







UNITED STATES COMMISSION OF FISH AND FISHERIES.

Acc^t 361 duplicate

PART XI.

REPORT

OF

THE COMMISSIONER


FOR

1883.

- A.—INQUIRY INTO THE DECREASE OF FOOD-FISHES.
B.—THE PROPAGATION OF FOOD-FISHES IN THE
WATERS OF THE UNITED STATES.



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.



Resolved by the Senate (the House of Representatives concurring), That the report of the Commissioner of Fish and Fisheries for the year 1883 be printed, and that there be printed 10,000 extra copies, of which 2,000 shall be for the use of the Senate, 6,000 for the use of the House of Representatives, 1,500 for the use of the Commissioner of Fish and Fisheries, and 500 for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication and 10 per cent thereto thereon added, the illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Public Printing.

Agreed to by the Senate May 14, 1884.

Agreed to by the House June 6, 1884.



CONTENTS.

I.—REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

	Page.
1. INTRODUCTORY REMARKS	xvii
Scope of the eleventh report.....	xvii
Recent expansion of operations.....	xvii
Educational services of the Commission.....	xviii
Demand for specimens collected.....	xviii
Noteworthy features of the year.....	xviii
(1) Completion of the Albatross.....	xviii
(2) Its use in studying schools of ocean fishes.....	xviii
(3) Use of the electric light.....	xviii
(4) A call from Great Britain for the Albatross.....	xviii
(5) Work of the Albatross in Caribbean Sea.....	xviii
(6) The hatching of Spanish mackerel.....	xviii
(7) Stranding of the Fish Hawk.....	xviii
(8) The acquisition of land at Wood's Holl.....	xviii
(9) Prosecution of work on the pier and breakwater at Wood's Holl.....	xviii
(10) The great International Fisheries Exhibition at London.....	xviii
(11) Examination of the ocean fisheries by a Senate committee.....	xviii
(12) Securing specimens of cetaceans, &c., through the Life-Saving Service.....	xviii
(13) Liberal co-operation of the railroads.....	xviii
(14) Adoption of a fishway for Great Falls.....	xix
(15) Laying out oyster ponds at Saint Jerome.....	xix
(16) Artificial propagation of oysters at Stockton.....	xix
(17) Improvements at Havre de Grace Station.....	xix
(18) Opening the Cold Spring Harbor Station.....	xix
(19) Survey of the Columbia River.....	xix
(20) Interruption of salmon work on the McCloud River.....	xix
(21) Increased production of whitefish at the Great Lakes.....	xix
(22) Introduction of whitefish at Mount Desert, Me.....	xix
(23) Action looking towards the protection of the Great Lakes fisheries.....	xix
(24) Shad-hatching at Fort Washington.....	xix
(25) Transferring shad eggs on trays.....	xix
(26) Acclimation of shad in the Sacramento River.....	xix
(27) Increase in the inshore cod-fisheries by the use of gill-nets.....	xix
(28) Reappearance of young cod hatched by the Commission.....	xix
(29) Efforts to hatch cod eggs from Fulton Market.....	xix
(30) A large distribution of German carp.....	xix
(31) Importation of blue carp.....	xx
(32) Discoveries in regard to the black cod as a food-fish.....	xx
(33) Hatching rockfish.....	xx
Work yet to be accomplished by the Commission.....	xx
(1) Completing the knowledge of the habits of the useful fishes and other aquatic animals and their proper identification, the collecting of specimens on a large scale, and their distribution to colleges and academies.....	xx
(2) The improvement of the methods of capture.....	xx
Great aid rendered in the past by the introduction of the cod gill-net.....	xx
Treatment of nets to prevent their rotting.....	xx
(3) Improvement in fishing vessels.....	xx

1. INTRODUCTORY REMARKS—Continued.

Work yet to be accomplished by the Commission—Continued.

(4) Survey of old fishing-grounds and the discovery of new ones	xxi
Field for discovery along the coasts of the South Atlantic and the Gulf States	xxi
(5) Improved methods of preparing and curing fish	xxi
Progress since the Centennial	xxi
(6) Stocking and restocking the waters with fish only begun	xxii
General conditions involved	xxii
Healthy public sentiment and suitable legislation brought about for the protection of the fisheries	xxii
Fishes of special promise and importance	xxiii
The oyster requiring special attention	xxiii
Correspondence of 1883	xxiii
Casualties among assistants and correspondents	xxiv
Death of Mr. Frank S. Eastman	xxiv
Death of Mr. O. M. Chase	xxiv
Office of the Commission	xxiv

2. PRINCIPAL STATIONS OF THE UNITED STATES COMMISSION.

A.—For investigation and research	xxiv
(1) Gloucester, Mass	xxiv
(2) Wood's Holl, Mass	xxiv
(3) Saint Jerome, Md.	xxiv
B.—For propagation of Salmonidæ	xxv
(4) Grand Lake Stream, Me. (Schoodic Salmon)	xxv
(5) Bucksport, Me. (Penobscot Salmon and Whitefish)	xxv
(6) Northville, Mich. (Whitefish and several species of Trout)	xxv
(7) Alpena, Mich. (Whitefish)	xxv
(8) Baird, Shasta County, Cal. (California Salmon)	xxv
(9) Trout ponds near Baird, Cal. (California Trout)	xxv
(10) Wytheville, Va. (Salmonidæ generally)	xxv
(11) Cold Spring Harbor, N. Y. (Schoodic and Penobscot Salmon)	xxv
C.—For propagation of Shad	xxvi
(12) Havre de Grace, Md.	xxvi
(13) Central Station, Washington, D. C.	xxvi
(14) Fort Washington, Md.	xxvi
D.—For propagation of Carp	xxvi
(15) Monument reservation, Washington, D. C.	xxvi
(16) Arsenal grounds, Washington, D. C.	xxvi

3. NEW HATCHING STATIONS ASKED FOR

1.—On the Columbia River	xxvi
By Hon. J. H. Slater	xxvi
By E. C. Holden, secretary	xxvii
By Hon. M. C. George	xxvii
2.—At Milwaukee, Wis	xxviii
By the Wisconsin Fish Commission	xxviii
By the Milwaukee Industrial Exposition	xxviii
By the Wisconsin legislature	xxviii

4. VESSELS OF THE COMMISSION

A.—The Albatross	xxviii
Movements of this vessel in 1883	xxx
Officer list of the vessel	xxx
Measurement of the vessel	xxx
Model of the vessel	xxxi
Loan to the Navy Department	xxxi
Lighted by electricity	xxxi
B.—The Fish Hawk	xxxi
Movements during 1883	xxxii
Work in Chesapeake Bay	xxxii
Work at Wood's Holl	xxxiii
Work at Saint Jerome	xxxiii
Personnel at the end of the year	xxxiii
C.—The Lookout	xxxiii
Its ownership, command, and work	xxxiv
D.—Herreshoff launch (No. 82) the Cygnet	xxxv
Navy launches	xxxv

	Page.
4. VESSELS OF THE COMMISSION—Continued.	
E.—The canvas-back	xxxv
F.—Proposed fishing schooner	xxxv
Its desirability and uses	xxxv
Captain Collins to prepare a model	xxxv
Loss of life from badly constructed schooners	xxxv
5. FISH HATCHING AND TRANSPORTATION CARS	xxxvi
Dimensions of car No. 1	xxxvi
Dimensions of car No. 2	xxxvi
Summary of the use made of them	xxxvi
6. COURTESIES EXTENDED TO THE U. S. FISH COMMISSION	xxxvi
A.—By the Government	xxxvi
The Treasury Department	xxxvi
Secretary's Office	xxxvi
Light-House Board	xxxvi
Coast Survey	xxxvii
Life-Saving Service	xxxvii
The War Department	xxxviii
Engineer Bureau	xxxviii
Signal Office	xxxviii
The Navy Department	xxxix
Bureau of Construction and Repair	xxxix
Bureau of Equipment and Recruiting	xxxix
Bureau of Ordnance	xxxix
The Post-Office Department	xxxix
The Interior Department	xxxix
Patent Office	xxxix
B.—By the railroads of the United States	xxxix
Special arrangement and prices for Fish Commission cars	xl
Free trips granted to cars by certain roads	xl
C.—By foreign steamship companies	xli
D.—By foreign countries	xli
Germany	xli
7. COURTESIES EXTENDED BY THE U. S. FISH COMMISSION TO FOREIGN COUNTRIES	xli
A.—Shipment of fish eggs to France	xli
B.—Shipment of fish and eggs to Germany	xli
C.—Shipment of fish eggs to Great Britain	xlii
D.—Shipment of fish and eggs to Belgium	xlii
E.—Shipment of carp to Cuba	xlii
F.—Shipment of carp to Brazil	xlii
G.—Shipment of fish eggs to United States of Colombia	xlii
H.—Shipment of carp to Mexico	xlii
8. THE LONDON AND OTHER FISHERIES EXHIBITIONS	xlii
Preparations, packing, and shipment of exhibit	xliii
The party accompanying the exhibit	xliii
Space assigned and installation	xliv
Opinions expressed concerning our exhibit	xlv
Courtesies extended to the party	xlvi
Fishery conferences and publications	xlvii
Jury work and work of specialists	xlvii
Anglers' tournament	xlviii
Closing of the exhibition and return of exhibits	xlviii
List of prizes awarded	xlix
Exhibition at Aalborg, Denmark	xlix
Names of contributors to the success of the London Exhibition	l
The official catalogue described	l
9. PUBLICATIONS OF THE FISH COMMISSION IN 1883	li
Annual reports	li
Fish Commission bulletins	li
Miscellaneous pamphlets	li
Carp pamphlets	li
Editing of publications in charge of C. W. Smiley	li
10. THE WOOD'S HOLL STATION	liii
Desirability of artificially propagating sea fishes	liii
Difficulties to be obviated	liii

	Page.
10.—THE WOOD'S HOLL STATION—Continued.	
Success in hatching cod at Gloucester	liv
Places proposed for a sea-coast station	liv
Facilities offered at Wood's Holl	liv
A pier and breakwater proposed	liv
Method of obtaining land	liv
Assistance of District Attorney Sanger	liv
Action of C. F. Choate and J. Malcolm Forbes as trustees	lv
Contract for building	lv
The buildings required	lv
Inadequacy of accommodations at Wood's Holl	lvi
11. VISITS FROM FOREIGN SPECIALISTS	lvi
Capt. G. M. Dannevig, of Norway	lvi
Henry Grosjean, of France	lvii
12. PROVISION FOR THE EVENT OF DISABILITY OF THE COMMISSIONER	lvii
Mr. T. B. Ferguson designated to act	lvii

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

13. THE INVESTIGATION OF THE MENHADEN FISHERY BY THE SENATE COMMITTEE	lvii
Objects of the undertaking	lvii
Work accomplished	lvii
14. THE FISHERY CENSUS OF 1880, AND ITS RESULTS	lviii
Recapitulation of the arrangements made	lviii
Contents of the fishery report to be published by the Commission	lix
Contents of the fishery report to be published by the Census	lix
List of special statistical tables published	lx
Analysis of Volume I of the quarto fishery report	lxii
Summary table of the United States fisheries	lxiv
15. SUPPOSED DESTRUCTION OF THE TILEFISH	lxvi
No tilefish found after repeated efforts	lxvi
16. THE POLE-FLOUNDER	lxvi
Increased range of the species ascertained	lxvi
Difficult to capture	lxvi
17. THE BLACK COD OF THE PACIFIC	lxvi
Where found	lxvii
Economic use proposed	lxvii
18. NEW MODEL OF FISHING VESSEL	lxvii
Schooner needed by the Commission	lxvii
Loss of life and property in the fisheries	lxviii
19. FISHERIES OF THE GULF OF MEXICO	lxviii
Decrease in the red-snapper fisheries	lxviii
20. TREATY OF WASHINGTON	lxix
Suggestion as to the steps to be taken	lxix
21. COD GILL-NETS	lxix
Some results of their use at Gloucester	lxix

C.—THE INCREASE OF FOOD-FISHES.

22. BY PROTECTIVE MEASURES	lxxi
Difficulties in the way of legislation	lxxi
The Senate committee's investigation	lxxi
Protection of the Great Lakes	lxxi
Nets of too small mesh in use	lxxi
Action of the Western fish commissioners	lxxii
23. BY THE USE OF FISHWAYS	lxxii
The Great Falls fishway	lxxii
24. DISTRIBUTION OF FISH AND EGGS	lxxii
General method of distribution	lxxii
Number of carp distributed	lxxii
Number of shad distributed	lxxiii
Number of whitefish distributed	lxxiii

	Page.
25. SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1883.....	lxxiii
General list of species covered by the operations of the Commission.....	lxxiii
a. The Codfish (<i>Gadus morrhua</i>).	
The Fulton Market (New York) Station	lxxiii
Results of previous efforts	lxxiii
b. The Spanish Mackerel (<i>Scomberomorus maculatus</i>).	
The Fish Hawk Station	lxxv
c. The Rockfish or Striped Bass (<i>Roccus lineatus</i>)	lxxv
d. The Mullet (<i>Mugil</i>)	lxxvi
e. The Whitefish (<i>Coregonus clupeiformis</i>).	
The Northville Station	lxxvi
The Alpena Station	lxxvii
The mode of depositing young fish	lxxvii
f. The Brook Trout (<i>Salvelinus fontinalis</i>).	
The Northville Station	lxxviii
g. The Lake Trout (<i>Salvelinus namaycush</i>).	
The Northville Station	lxxviii
h. The Saibling (<i>Salmo salvelinus</i>).	
Receipts of eggs from Germany	lxxviii
i. The California, Rainbow, or Mountain Trout (<i>Salmo irideus</i>).	
The McCloud River Station	lxxix
The Northville Station	lxxix
Advantages of planting them in the East.....	lxxix
j. The Atlantic or Penobscot Salmon (<i>Salmo salar</i>).	
The Bucksport Station	lxxx
The Northville Station	lxxx
k. The Schoodic or Landlocked Salmon (<i>Salmo salar</i> subsp. <i>sebago</i>).	
The Grand Lake Stream Station	lxxxi
l. The European Trout (<i>Salmo fario</i>).	
Receipt of eggs from Germany	lxxxi
m. The Quinnet or California Salmon (<i>Oncorhynchus chouicha</i>).	
The McCloud River Station	lxxxi
n. The Shad (<i>Clupea sapidissima</i>).	
The Quantico Station	lxxxiii
The Fort Washington Station	lxxxiv
Central Station, Washington, D. C.	lxxxiv
The Battery Island Station	lxxxiv
The fisheries of Havre de Grace, Md.....	lxxxv
Pamphlet of instructions to spawn-takers.....	lxxxv
r. The Carp (<i>Cyprinus carpio</i>).	
The Washington stations	lxxxvi
New ponds	lxxxvi
p. The Goldfish (<i>Carassius auratus</i>).	
The Central Station	lxxxvii
q. The Golden Ide or Orf (<i>Leuciscus idus</i>).	
The Washington stations	lxxxvii
r. The Tench (<i>Tinca vulgaris</i>).....	lxxxvii
s. The Catfish (<i>Amiurus</i>).	
Its desirability for propagation	lxxxvii
The speckled catfish.....	lxxxvii
t. The Clams.	
Transplanting Pacific coast species	lxxxviii
u. The American Lobster (<i>Homarus americanus</i>).	
Its rapid diminution	lxxxviii
Its artificial propagation	lxxxviii
Transplanting to the Chesapeake.....	lxxxviii
v. The Oyster (<i>Ostrea virginica</i>).	
Experiments made	lxxxix
Mr. Ryder's work at Stockton	lxxxix
Efforts abroad.....	xc
Work of Brooks, Winslow, Hudson, Pike, and Ryder.....	xc

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

26. CLASSIFICATION OF ARTICLES.....	xc
A.—General	xcii
B.—The fisheries	xcii

	Page.
26. CLASSIFICATION OF ARTICLES—Continued.	
C.—Economic research	xciii
D.—Natural history and biological research.....	xciii
E.—Propagation of food-fishes	xciii
F.—Miscellaneous.....	xciv

E.—SUPPLEMENT TO THE REPORT PROPER.

27. LIST OF LIGHT-HOUSE KEEPERS FURNISHING OCEAN TEMPERATURES	xciv
---	------

II.—APPENDIX TO REPORT OF COMMISSIONER.

APPENDIX A.—GENERAL.

I. Tanner. REPORT ON THE CONSTRUCTION AND OUTFIT OF THE U. S. FISH COMMISSION STEAMER ALBATROSS. By Lieut.-Commander Z. L. Tanner, U. S. Navy. Fifty-five plates, 20 figures. Special index	3
II. Tanner. REPORT ON THE WORK OF THE U. S. FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING DECEMBER 31, 1883. By Lieut.-Commander Z. L. Tanner, U. S. Navy, commanding. Three plates. Special index.....	117
III. Stone. EXPLORATIONS ON THE COLUMBIA RIVER FROM THE HEAD OF CLARKE'S FORK TO THE PACIFIC OCEAN, MADE IN THE SUMMER OF 1883, WITH REFERENCE TO THE SELECTION OF A SUITABLE PLACE FOR ESTABLISHING A SALMON-BREEDING STATION. By Livingston Stone. Special index	237
IV. THE BRITISH SEA-FISHERIES ACT, 1883	269

APPENDIX B.—THE FISHERIES.

V. Smiley. THE PRINCIPAL RIVER FISHERIES OF THE UNITED STATES, WITH AN ESTIMATE OF THE CATCH FOR 1880. By Charles W. Smiley. Special index	281
VI. Smiley. STATISTICS OF THE UNITED STATES IMPORTS AND EXPORTS OF FISH, FISH-OIL, WHALEBONE, THE TONNAGE OF FISHING VESSELS, &C., FOR THE YEAR ENDING JUNE 30, 1883. By Charles W. Smiley	301
VII. Duff. ON THE FISHERIES OF GREAT BRITAIN AND THE FISHERIES EXHIBITION OF 1883. By R. W. Duff, M. P.	317
VIII. Smiley. REVIEW OF THE WHALE FISHERY FOR 1882 AND 1883. Compiled by Charles W. Smiley	325
IX. SVEND FOYN'S WHALING ESTABLISHMENT. From the <i>Deutsche Fischerei-Zeitung</i>	337
X. Ljungman. THE GREAT HERRING FISHERIES CONSIDERED FROM AN ECONOMICAL POINT OF VIEW. By Axel Vilhelm Ljungman.....	341
XI. THE NORWEGIAN FISHERIES IN 1883, WITH STATISTICS OF PREVIOUS YEARS. From the <i>Norsk Fiskeritidende</i>	359
XII. Trolle. THE ICELAND COD-FISHERIES IN 1883. By C. Trolle, first lieutenant in the Danish navy	371
XIII. Day. THE FISHERIES OF INDIA. By Francis Day, F. L. S., F. Z. S., deputy surgeon-general (retired), formerly inspector-general of fisheries of India.....	383
XIV. Lundberg. EEL-FISHING WITH SO-CALLED "HOMMOR" (A SPECIES OF FISH-POT) ON THE BALTIC COAST OF SWEDEN AND IN THE SOUND. By Rudolph Lundberg. One plate	415

APPENDIX C.—ECONOMIC RESEARCH.

XV. Atwater. CONTRIBUTIONS TO THE KNOWLEDGE OF THE CHEMICAL COMPOSITION AND NUTRITIVE VALUES OF AMERICAN FOOD-FISHES AND INVERTEBRATES. By W. O. Atwater, Ph. D., professor of chemistry in Wesleyan University, Middletown, Conn. Two plates. Special index	433
---	-----

APPENDIX D.—NATURAL HISTORY AND BIOLOGICAL RESEARCH.

XVI. Verrill. RESULTS OF THE EXPLORATIONS MADE BY THE STEAMER ALBATROSS OFF THE NORTHERN COAST OF THE UNITED STATES IN 1883. By A. E. Verrill. Forty-four plates. Special index	503
XVII. Bush. LIST OF DEEP-WATER MOLLUSCA DREDGED BY THE U. S. FISH COMMISSION STEAMER FISH HAWK IN 1880, 1881, AND 1882, WITH THEIR RANGE IN DEPTH. By Katharine J. Bush. Special index	701

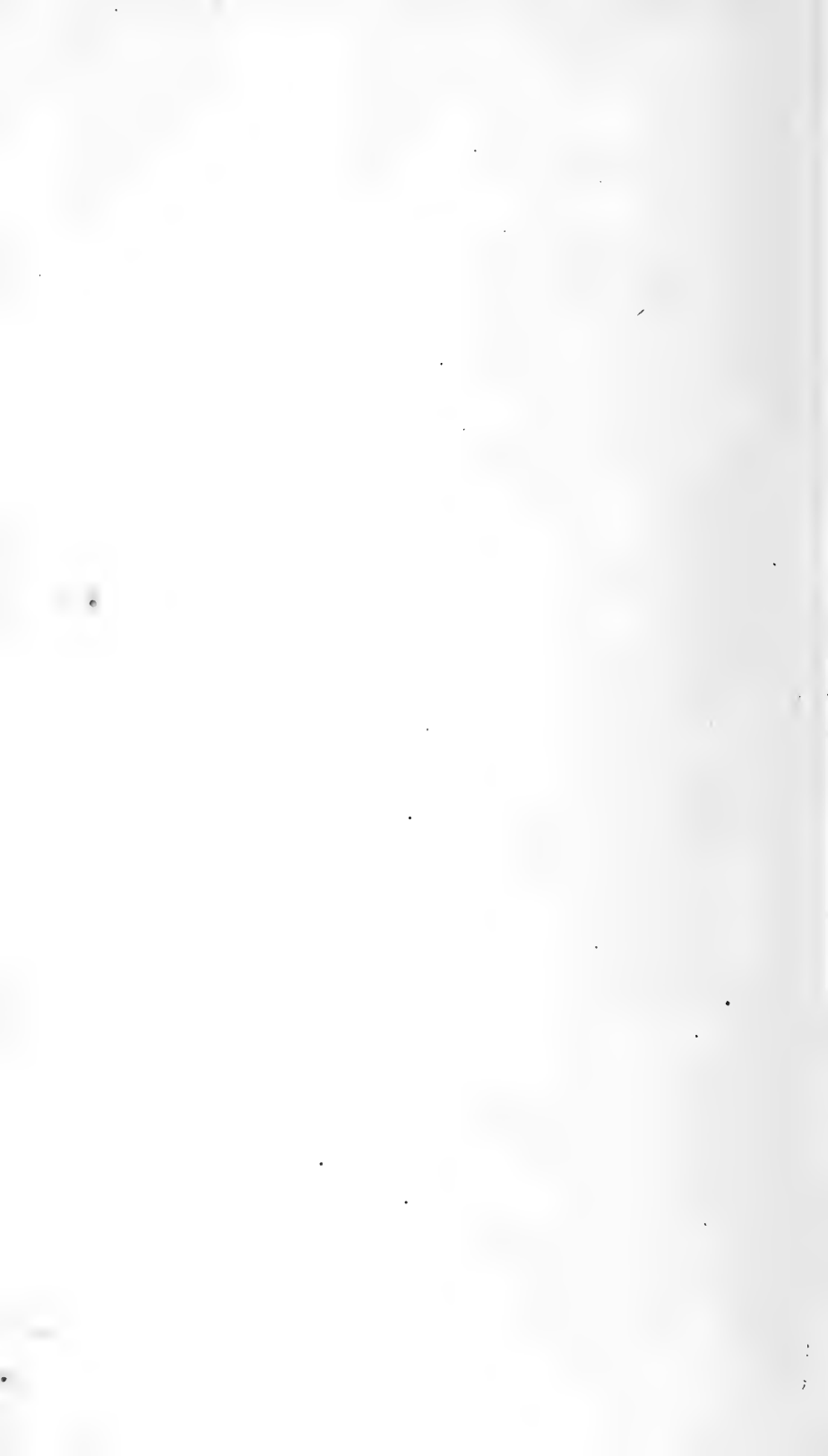
	Page.
XVIII. Ljungman. SPECIAL RESULTS OF THE INVESTIGATIONS RELATING TO THE HERRING AND HERRING FISHERIES ON THE WEST COAST OF SWEDEN, MADE DURING THE YEARS 1873 TO 1884. By A. V. Ljungman.....	729
XIX. Shufeldt. THE OSTEOLOGY OF AMIA CALVA, INCLUDING CERTAIN SPECIAL REFERENCES TO THE SKELETON OF TELEOSTEANS. By R. W. Shufeldt, M. D., captain Medical Corps, U. S. Army. Fourteen plates. One figure. Special index.....	747
XX. Eisen. OLIGOCHÆTOLOGICAL RESEARCHES. By Gustav Eisen. Nineteen plates. Special index.....	879
XXI. Seal. THE AQUA-VIVARIUM AS AN AID TO BIOLOGICAL RESEARCH. By William P. Seal. Three plates.....	965

APPENDIX E.—PROPAGATION OF FOOD-FISHES.

XXII. Mather. ACCOUNT OF EGGS REPACKED AND SHIPPED TO FOREIGN COUNTRIES UNDER DIRECTION OF THE U. S. FISH COMMISSION DURING THE SEASON OF 1883-'84. By Fred Mather..	973
XXIII. Clark. REPORT OF OPERATIONS AT NORTHVILLE AND ALPENA STATIONS FOR THE SEASON OF 1883-'84. By Frank N. Clark.....	975
XXIV. Stone. REPORT OF OPERATIONS AT THE U. S. SALMON-BREEDING STATION ON THE MC-CLOUD RIVER, CALIFORNIA, DURING THE YEAR 1883. By Livingston Stone.....	989
XXV. Stone. REPORT OF OPERATIONS AT THE U. S. TROUT-BREEDING STATION ON THE MC-CLOUD RIVER, CALIFORNIA, DURING THE YEAR 1883. By Livingston Stone.....	1001
XXVI. Atkins. REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1883-'84. By Charles G. Atkins.....	1007
XXVII. Atkins. REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1883-'84. By Charles G. Atkins.....	1011
XXVIII. McDonald. REPORT OF OPERATIONS AT CENTRAL STATION, U. S. FISH COMMISSION, DURING 1883. By Marshall McDonald. One plate.....	1017
XXIX. Babcock. REPORT OF SHAD OPERATIONS CONDUCTED AT FORT WASHINGTON, MARYLAND, IN THE SPRING OF 1883. By Lieut. William C. Babcock, U. S. Navy.....	1035
XXX. Low. REPORT OF OPERATIONS AT THE HAVRE DE GRACE SHAD-HATCHING STATION DURING PART OF THE SEASON OF 1883. By Lieut. W. F. Low, U. S. Navy.....	1043
XXXI. Clark. NOTES ON EXPERIMENTS IN PENNING SHAD AND TAKING EGGS AT BATTERY STATION, HAVRE DE GRACE, MD., IN 1883. By Frank N. Clark.....	1045
XXXII. McDonald. REPORT OF THE DIVISION OF DISTRIBUTION OF THE U. S. FISH COMMISSION FOR THE YEAR 1883. By Marshall McDonald.....	1051
XXXIII. Wood. REPORT OF OPERATIONS IN HATCHING EGGS OF SPANISH MACKEREL IN CHESAPEAKE BAY BY STEAMER FISH HAWK DURING THE SUMMER OF 1883. By Lieut. W. M. Wood, U. S. Navy, commanding.....	1089
XXXIV. Kite. REPORT UPON APPARATUS AND FACILITIES NEEDED FOR HATCHING SPANISH MACKEREL. By J. Alban Kite, M. D. Two figures.....	1095
XXXV. Benecke. UTILIZING WATER BY FISH-CULTURE. By Prof. B. Benecke. Five plates.	1101
XXXVI. Borne. HOW TO RAISE CARP AND OTHER POND FISH WHICH SPAWN IN SUMMER. By Max von dem Borne.....	1133
XXXVII. Gasch. POND CULTURE—THE FOOD AND SPAWNING OF CARP. By Adolph Gasch..	1143

APPENDIX F.—MISCELLANEOUS.

XXXVIII. Wood. REPORT OF OPERATIONS AT SAINT JEROME STATION IN LAYING OUT OYSTER PONDS BY THE STEAMER FISH HAWK IN 1883. By Lieut. W. M. Wood, commanding.....	1153
XXXIX. True. SUGGESTIONS TO THE KEEPERS OF THE U. S. LIFE-SAVING STATIONS, LIGHT-HOUSES, AND LIGHT-SHIPS, AND TO OTHER OBSERVERS, RELATIVE TO THE BEST MEANS OF COLLECTING AND PRESERVING SPECIMENS OF WHALES AND PORPOISES. By Frederick W. True, Curator of Mammals in the U. S. National Museum. Eleven plates. Five figures. Special index...	1157
XL. STATEMENTS CONCERNING THE FISHERIES OF SEVERAL COUNTRIES. Compiled from the Consular Report for 1882 and 1883.....	1183
GENERAL INDEX.....	1201



LIST OF ILLUSTRATIONS.

THE ALBATROSS.*

	Page.
FRONTISPIECE.—The Albatross	3
FIG. —Herreshoff steam cutter	15
—Herreshoff steam gig	16
1.—Action of the Svedberg governors	28
2.—Details of pumps	29
3.—The electric engine	30
4.—The dynamo	33
5.—Lamp fixture—bracket	34
6.—Single-swing bracket	35
7.—Double-swing bracket	35
8.—Arrangement of the wires	36
9.—Lamp-socket	36
10.—Lamp	36
11.—Socket	36
12.—Lamp and socket connected	37
13.—Cut-out blocks and safety plugs	37
14.—The same—reverse view	38
15.—Wise motor	41
16.—Herreshoff double-coil boiler	44
17.—Engine of Herreshoff cutter	45
18.—Pressure-regulating valve	51
19.—Chester's wing net	86
20.—The angle and scope of dredge rope	97
PLATE	
I.—The Albatross dredging	112
II.—Plans of the Albatross	112
III.—The cabin	112
IV.—Upper laboratory	112
V.—Chart room	112
VI.—Interior of the pilot-house; steam steering engine	112
VII.—Berth deck, looking from forward aft	112
VIII.—Steerage	112
IX.—Lower laboratory, looking from forward aft	112
X.—Lower laboratory, looking from aft forward	112
XI.—Ward room	112
XII.—Lieut. W. M. Wood's boat detaching apparatus	112
XIII.—Auxiliary steering gear	112
XIV.—Steam windlass and capstan	112
XV.—Compound twin-screw engines	112
XVI.—The return flue boiler	112
XVII.—Circulating pump	112
XVIII.—Svedberg's marine governor	112
XIX.—Ash elevator and chute	112
XX.—Ash-hoisting engine	112
XXI.—Fresh-water distiller	112
XXII.—Edison dynamo and Armington & Sims engine	112
XXIII.—Dredging engine	112
XXIV.—Dredging engine	112
XXV.—Reeling engine	112
XXVI.—Steam pumps	112

* In Tanner's Construction and Outfit of the Albatross.

	Page.
PLATE XXVII.—Sigsbee's machine for sounding with wire, rigged for reeling in	111
XXVIII.—Belt-tightener, ratchet crank, and dredging quadrant	112
XXIX.—Tanner sounding machine	112
XXX.—Wire splices	112
XXXI.—Soldering lamp	112
XXXII.—Measuring reel and blade	112
XXXIII.—Sigsbee's detacher, used in connection with a modification of Captain Belknap's sounding cylinder, No. 2	112
XXXIV.—Sigsbee's water-specimen cup	112
XXXV.—Improved water-bottle	112
XXXVI.—Improved water-bottle, sectional elevation	112
XXXVII.—Improved water-bottle—details	112
XXXVIII.—Negretti & Zambra's patent improved frame standard deep-sea thermometer	112
XXXIX.—The Tanner improved thermometer-case, with the Sigsbee clamp, used with the Negretti & Zambra deep-sea thermometer	112
XL.—The Miller-Casella deep-sea thermometer	112
XLI.—Hilgard's ocean salinometer	112
XLII.—The bow of the Albatross, showing the location of the dredging boom and sounding machines	112
XLIII.—Dredging block	112
XLIV.—The accumulator	112
XLV.—Safety hooks	112
XLVI.—Deep-sea trawl-framer	112
XLVII.—Beam trawl-frame	112
XLVIII.—Improved beam trawl	112
XLIX.—Common dredge, Chester rake dredge, and Blake dredge	112
L.—Tangle bar	112
LI.—The tangles	112
LII.—The cradle sieve, table sieve, and strainer	112
LIII.—Sigsbee's gravitating trap, for obtaining animal forms from intermedial ocean depths	112
LIV.—Sigsbee's gravitating trap—details	112
LV.—Sigsbee's gravitating trap—details	112

THE ALBATROSS.*

FIG. 1.—Ice-house and cold-room	207
PLATE I.—Steering card	230
II.—Illustrative cases in navigation (1 and 2)	230
III.—Illustrative case in navigation (3)	230

EEL FISHING IN THE BALTIC.†

FIG. 1.—Plan of the "hommor" or fish-pot	424
2.—The same	424
PLATE I.—Diagram of variations in the eel fisheries in Scania, from 1815 to 1880	430

CHEMICAL COMPOSITION OF FISH.

PLATE I.—Nutritive ingredients, water, and refuse in specimens of fish and other food materials as found in the market	494
II.—Nutritive ingredients, water, &c., in flesh, edible portion of fish and other animal foods	494

SPECIMENS OBTAINED BY THE ALBATROSS.§

PLATE I.—Umbellula Bairdii, Umbellula Guntheri	604
II.—Benthoptilum sertum, Lepidogorgia gracilis, Anthomastus grandiflorus, Gersemia longiflora, Lepidisis caryophyllia	606
III.—Kophobelemnion tenue, Scleroptilum gracile, Pennatula aculeata, Balticina Finmarchica, Lepidisis caryophyllia	608
IV.—Pennatula (Ptilella) borealis	610

* In Tanner's Report on the Work of the Albatross.

† In Lundberg's Eel Fisheries.

‡ In Atwater's Report on the Chemical Composition of Fish and Invertebrates

§ In Verrill's Results of the Albatross Explorations in 1883.

PLATE	Page
V.— <i>Flabellum Goodei</i> , <i>Flabellum angulatum</i> , <i>Caryophyllia communis</i> , <i>Dasmosmilia Lymani</i> , <i>Actinauge nodosa</i> , <i>Actinauge nodosa</i> var. <i>tuberculosa</i>	612
VI.— <i>Urticina perdix</i> , <i>Epizoanthus abyssorum</i> , <i>Parapagurus pilosimanus</i>	614
VII.— <i>Actinauge longicornis</i> , <i>Actinauge nexilis</i> , <i>Balticina Finmarchica</i> , <i>Actinernus nobilis</i> , <i>Sagartia spongicola</i>	616
VIII.— <i>Adamsia sociabilis</i> , <i>Catapagurus Sbarreri</i> , <i>Epizoanthus paguriphilus</i> , <i>Parapagurus pilosimanus</i>	618
IX.— <i>Anthoptilum grandiflorum</i> , <i>Cladocarpus flexilis</i> , <i>Calicella plicatilis</i> , <i>Dasygorgia Agassizii</i>	620
X.— <i>Benthodytes gigantea</i> , <i>Euphronides cornuta</i> , <i>Lophothuria Fabricii</i>	622
XI.— <i>Benthodytes gigantea</i>	624
XII.— <i>Euphronides cornuta</i>	626
XIII.— <i>Pteraster militaris</i> , <i>Archaster Floræ</i> , <i>Archaster Parelii</i> , <i>Archaster tenuispinus</i> , <i>Luidia elegans</i> , <i>Asterias Tanneri</i> , <i>Solaster Earlii</i>	628
XIV.— <i>Porcellanaster cœruleus</i> , <i>Diplopteraster multipes</i>	630
XV.— <i>Porania grandis</i>	632
XVI.— <i>Porania grandis</i> , <i>Lophaster furcifer</i>	634
XVII.— <i>Hippasteria phrygiana</i> , <i>Brisinga Americana</i>	636
XVIII.— <i>Asterina borealis</i> , <i>Astrogonium granulare</i> , <i>Tremaster mirabilis</i>	638
XIX.— <i>Solaster Earlii</i>	640
XX.— <i>Astrochele Lymani</i> , <i>Astronyx Loveni</i> , <i>Amphiura tenuispina</i> , <i>Ophioscolex quadrispinus</i>	642
XXI.— <i>Rhizocrinus Lofoteusis</i> , <i>Antedon dentata</i>	644
XXII.— <i>Abrulia megalops</i> , <i>Leptoteuthis diaphana</i> , <i>Eledonella pygmæa</i> , <i>Octopus pictus</i>	646
XXIII.— <i>Argonauta argo</i>	648
XXIV.— <i>Pleurotoma Dalli</i> , <i>Pleurotomella Agassizii</i> , <i>Pleurotomella Bairdii</i> , <i>Pleurotomella Pandionis</i> , <i>Pleurotomella Benedicti</i> , <i>Pleurotomella Sandersoni</i> , <i>Pleurotomella Saffordi</i> , <i>Pleurotomella bandella</i> , <i>Pleurotomella Emertoni</i>	650
XXV.— <i>Pleurotomella Bruneri</i> , <i>Pleurotomella Catherina</i> , <i>Taranis pulchella</i> , <i>Typhlomangilia Tanneri</i> , <i>Marginella borealis</i> , <i>Buccinum abyssorum</i> , <i>Sipho profundicola</i> , <i>Sipho glyptus</i> , <i>Cingula Jan Mayeni</i> , <i>Scalaria Grœnlandica</i> , <i>Scalaria Dalliana</i> , <i>Scalaria Pourtalesii</i> , <i>Scalaria Leeana</i> , <i>Scalaria Andrewsii</i>	652
XXVI.— <i>Dolium Bairdii</i> , <i>Benthodolium abyssorum</i> , <i>Torellia fimbriata</i> , <i>Fossarus elegans</i> , <i>Seguenzia formosa</i> , <i>Seguenzia eritima</i>	654
XXVII.— <i>Solarium boreale</i> , <i>Calliostoma Bairdii</i> , <i>Margarita regalis</i> , <i>Margarita lamellosa</i> , <i>Cyclostrema Dalli</i> , <i>Addisonia paradoxa</i> , <i>Cocculina leptalea</i> , <i>Placophora Atlantica</i> , <i>Amicula Emersonii</i> , <i>Turbonilla Rathbuni</i>	656
XXVIII.— <i>Pleurobranchæa tarda</i> , <i>Scaphander nobilis</i> , <i>Koonsia obesa</i> , <i>Issa ramosa</i> , <i>Scyllæa Edwardsii</i> , <i>Glaucus margaritaceus</i> , <i>Dentalium occidentale</i> , <i>Cadulus Pandionis</i>	658
XXIX.— <i>Atlanta Peronii</i> , <i>Atlanta Gaudichaudii</i> , <i>Firola Keraudrenii</i> , <i>Pleuropus Hargeri</i> , <i>Diacria trispinosa</i> , <i>Cavolina uncinata</i> , <i>Triptera columnella</i> , <i>Styliola recta</i> , <i>Styliola striata</i> , <i>Cymbulia calceolus</i> , <i>Spongiobranchia australis</i> , <i>Clione papilionacea</i>	660
XXX.— <i>Teredo megotara</i> , <i>Poromya sublevis</i> , <i>Neera multicostata</i> , <i>Thracia nitida</i> , <i>Verticordia cœlata</i> , <i>Mytilimeria flexuosa</i> , <i>Pholadomya arata</i> , <i>Diplodonta turgida</i>	662
XXXI.— <i>Diplodonta turgida</i> , <i>Yoldia thraciformis</i> , <i>Yoldia sapotilla</i> , <i>Leda acuta</i> , <i>Pecten vitreus</i> , <i>Pecten pustulosus</i> , <i>Culeolus Tanneri</i>	664
XXXII.— <i>Doliolum</i> , sp., <i>Salpa Caboti</i> , <i>Salpa clotho</i>	666
XXXIII.— <i>Lithodes Agassizii</i>	668
XXXIV.— <i>Pentacheles sculptus</i>	670
XXXV.— <i>Munida Caribæa</i> , <i>Glyptocrangon sculptus</i>	672
XXXVI.— <i>Ceraphilus Agassizii</i> , <i>Sabinea princeps</i> , <i>Phronima</i> , sp., <i>Sycenus infelix</i> , <i>Cirrolana impressa</i> , <i>Anthecheres Dubenii</i>	674
XXXVII.— <i>Geryon quinqueodus</i>	676
XXXVIII.— <i>Colossendeis collosea</i> , <i>Colossendeis macerrima</i> , <i>Scærorhynchus armatus</i>	678
XXXIX.— <i>Polynoë Aranella</i> , <i>Læmatonice armata</i>	680
XL.— <i>Polynoë aurantiaca</i> , <i>Polynoë (Harmothoë) imbricata</i> , <i>Leanira robusta</i> , <i>Notophyllum Americanum</i>	682
XLI.— <i>Hyalinœcia artifex</i> , <i>Leodice polybranchia</i> , <i>Nothria conchophila</i>	684

PLATE		Page.
XLII.—	<i>Amphinome Lepadis</i> , <i>Syllis spongiphila</i> , <i>Ophioglycera grandis</i> , <i>Sabella picta</i> , <i>Vermilia serrula</i> , <i>Maldane biceps</i>	686
XLIII.—	<i>Dipolydora concharum</i> , <i>Lepræa abyssicola</i> , <i>Priapulius</i> , sp., <i>Phascolosoma</i> , sp., <i>Tristoma cornutum</i> , <i>Tristoma læve</i> , <i>Cerebratulus luridus</i> , <i>Sagitta gracilis</i>	688
XLIV.—	<i>Sagartia Acanella</i> , <i>Sagartia abyssicola</i> , <i>Acanella Normani</i> , <i>Hyalinoccia arti-</i> <i>fex</i> , <i>Cladorhiza grandis</i>	690

OSTEOLOGY OF AMIA CALVA.*

FIG.	1.—Left lateral view of cranium of <i>Micropterus salmoides</i>	805
PLATE	I.—Cranium of <i>Amia calva</i>	842
	II.—Skull and primoidal cranium of <i>Amia calva</i>	844
	III.—Cranium and vertebræ of <i>Amia calva</i> , and view of mandible of a Teleostean fish (<i>Micropterus salmoides</i>)	846
	IV.—Right lateral view of the skull of <i>Amia calva</i>	848
	V.—Inner aspect of the right half of mandible of <i>Amia calva</i>	850
	VI.—The palatopterygoidean arcade of <i>Amia calva</i>	852
	VII.—Mandible of <i>Amia calva</i> , and cranium of a perch (<i>Perca Americana</i>)	854
	VIII.—Upper jaw, shoulder girdle, and pectoral limb of <i>Micropterus salmoides</i> , and like parts in <i>Amia calva</i>	856
	IX.—Skeleton of the caudal extremity of <i>Amia</i>	858
	X.—Left lateral view of the skeleton of <i>Amia calva</i>	860
	XI.—Left lateral view of the skull of <i>Micropterus salmoides</i>	862
	XII.—Palatoquadrate arch, right side, inner aspect, and right lateral views of cranium of <i>Albula vulpes</i>	864
	XIII.—Superior and inferior views of cranium of <i>Albula vulpes</i> , and opercular bones, hyoid, symplectic, and other elements of <i>Micropterus salmoides</i>	866
	XIV.—Posterior view and right lateral view of cranium of <i>Megalops</i> , and shoulder girdle and pectoral fin of <i>Micropterus salmoides</i>	868

OLIGOCHÆTOLOGICAL RESEARCHES.†

PLATE	I.— <i>Telmatodrilus Vejdoskyi</i>	926
	II.— <i>Telmatodrilus Vejdoskyi</i> , <i>Spirosperma ferox</i>	928
	III.— <i>Spirosperma ferox</i>	930
	IV.— <i>Ilyodrilus Perrierii</i>	932
	V.— <i>Ilyodrilus fragilis</i>	934
	VI.— <i>Ilyodrilus sodalis</i>	936
	VII.— <i>Hemitubifex insignis</i>	938
	VIII.— <i>Hemitubifex insignis</i> , <i>Tubifex campanulatus</i>	940
	IX.— <i>Limnodrilus ornatus</i>	942
	X.— <i>Limnodrilus Steigerwaldii</i>	944
	XI.— <i>Limnodrilus monticola</i>	946
	XII.— <i>Limnodrilus alpestris</i>	948
	XIII.— <i>Limnodrilus Silvani</i>	950
	XIV.— <i>Limnodrilus Silvani</i>	952
	XV.— <i>Camptodrilus igneus</i>	954
	XVI.— <i>Camptodrilus corallinus</i>	956
	XVII.— <i>Limnodrilus alpestris</i> , <i>Camptodrilus corallinus</i> , <i>Camptodrilus spiralis</i>	958
	XVIII.— <i>Camptodrilus igneus</i> , <i>Camptodrilus corallinus</i> , <i>Camptodrilus Californicus</i>	960
	XIX.— <i>Telmatodrilus Vejdoskyi</i> , <i>Limnodrilus alpestris</i>	962

AQUA-VIVARIUM.‡

PLATE	I.—Least expensive form of aqua-vivarium	970
	II.—More elaborate form of aqua-vivarium	970
	III.—Still more elaborate form of aqua-vivarium	970

WATER TEMPERATURES.§

PLATE I.—	Diagram showing the fluctuations of water temperature in the Chesapeake Bay and Potomac River from July 1, 1882, to June 30, 1883	103
-----------	--	-----

* In Shufeldt's Osteology of *Amia calva*.

† In Eisen's Oligochaetological Researches.

‡ In Seal's Aqua-Vivarium as an Aid to Biological Research.

§ In McDonald's Report of Central Station.

HATCHING SPANISH MACKEREL.*

WOOD.

Page.

FIG. 1.—Apparatus for hatching Spanish mackerel	1091
---	------

KITE.

FIG. 1.—Aquarium for hatching Spanish mackerel	1096
2.—Apparatus proposed for hatching floating eggs	1098

FISH PONDS. †

PLATE I	1132
FIG. 1.—Valley, to be transformed into ponds by means of dikes.	
2.—Staking out the dike.	
3.—Position of the pieces of sod.	
PLATE II	1132
FIG. 4.—Section of dike.	
5.—Fish-pit and ditches.	
6.—Protection posts against thieves.	
PLATE III	1132
FIG. 7.—Sluice.	
8.—Tap-outflow.	
9.—The tap-house.	
PLATE IV	1132
FIG. 10.—Section of a "monk."	
11.—Perspective view of a "monk."	
12.—Transverse section of the perpendicular pipe of a narrow "monk."	
13.—Transverse section of the perpendicular pipe of a broad "monk."	
PLATE V	1132
FIG. 14.—Dike with weir, grating, and floating beam.	
15.—Weir.	
16.—Angular grate.	
17.—Portable net for carrying carp.	

CETACEANS. ‡

FIG. 1.—Showing the organs and regions of the body to which special names are applied	1168
2.—Pelvic bone of a porpoise, natural size	1169
3.—Ideal figure of a porpoise, showing by cross-lines at what points the bones of the skeleton may be most conveniently separated	1170
4.—View of the under side of the skull of a whale, showing the position of A A, the ear-bones; B B, the cheek-bones	1171
5.—View of the upper side of the skull of a whale, showing the position of A A, the nose-bones	1171
PLATE I	1180
FIG. 1.— <i>Platanista gangetica</i> . The Susu.	
2.— <i>Inia Geoffroyi</i> . The Inia.	
3.— <i>Pontoporia Blainvillei</i> . The Pontoporia.	
PLATE II	1180
FIG. 4.— <i>Sotalia fluviatilis</i> . River Dolphin.	
5.— <i>Stenopercillatus</i> . Long-beaked Dolphin.	
6.— <i>Tursiops tursio</i> . Common Bottle-nose Dolphin.	
PLATE III	1180
FIG. 7.— <i>Delphinus delphis</i> . Common Dolphin.	
8.— <i>Prodelphinus punctatus</i> . Spotted Dolphin.	
9.— <i>Leucorhamphus borealis</i> . Right-whale Porpoise.	
PLATE IV	1180
FIG. 10.— <i>Lagenorhynchus gubernator</i> . Striped Dolphin.	
11.— <i>Cephalorhynchus Heavisidei</i> . White-marked Porpoise.	
12.— <i>Phocaena communis</i> . Common Harbor Porpoise.	

* In Wood's and Kite's Spanish Mackerel Papers.

† In Benecke's Utilizing Water by Fish-Culture.

‡ In True's Suggestions to Light-House Keepers and others, relative to collecting specimens of whales and porpoises

	Page.
PLATE V	1180
FIG. 13.— <i>Neomeris phocaenoides</i> . The Nameno-juo.	
14.— <i>Delphinopterus leucus</i> . White Whale.	
15.— <i>Monodon monoceros</i> . Narwhal.	
PLATE VI	1180
FIG. 16.— <i>Orcella fluminalis</i> . Indian River-dolphin.	
17.— <i>Grampus griseus</i> . Grampus.	
18.— <i>Globiocephalus melas</i> . Blackfish.	
PLATE VII	1180
FIG. 19.— <i>Pseudorca crassidens</i> . False Killer.	
20.— <i>Orca atra</i> . Killer.	
21.— <i>Physeter catodon</i> . Sperm Whale.	
PLATE VIII	1180
FIG. 22.— <i>Kogia breviceps</i> . Pigmy Sperm Whale.	
23.— <i>Ziphius novæ-zealandiæ</i> .	
24.— <i>Mesoplodon Sowerbiensis</i> . Sowerby's Whale, female.	
24 a.—Head of male Sowerby's Whale.	
PLATE IX	1180
FIG. 25.— <i>Berardius Arnuxi</i> . Arnux's Whale.	
26.— <i>Hyperoodon rostratus</i> . Bottlenose Whale, female.	
27.— <i>Rhachianectes glaucus</i> . California Gray Whale.	
PLATE X	1180
FIG. 28.— <i>Megaptera versabilis</i> . Pacific Humpback Whale.	
29.— <i>Balænoptera Davidsoni</i> . Little Piked Whale.	
30.— <i>Physalus antiquorum</i> . Common Finback Whale.	
PLATE XI	1180
FIG. 31.— <i>Sibbaldius veliferus</i> . Pacific Finback Whale.	
32.— <i>Balæna mysticetus</i> . Bowhead Whale.	

REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

I.—INTRODUCTORY REMARKS.

The present volume (for 1883) constitutes the eleventh of the series of annual reports of the work of the United States Fish Commission as ordered by Congress, and is intended to give an account of the proceedings of the Commission in its various divisions.

With the completion of the buildings at Wood's Holl the Commission hopes to be ready to carry out, on such scale as may be authorized by Congress, the various functions intrusted to it.

With the acquisition, with the means provided by Congress, of steamers capable of carrying on work in the ocean, as well as in the interior waters, the possibilities of usefulness have become greatly extended, and much has been attempted as well as accomplished. In addition to the regular work of the Commission, it has become possible to do a great deal for the advancement of science in general, especially by prosecuting researches into the general natural history of the aquatic animals and plants, either by persons officially connected with the Commission or by specialists to whom the facilities of the service are extended in the way of the use of boats, stations, and material.

The Commission has also made very large collections of aquatic animals, especially of fishes, shells, corals, crustaceans, starfishes, &c., and after submitting them to a careful investigation for monographic research, and setting aside a full series for the National Museum, the remainder has been made up into well-identified and labeled sets for distribution to colleges, academies, and other institutions of learning throughout the United States. The educational advantages of this last measure have proved to be of the utmost value, and are thoroughly appreciated by teachers throughout the country. Applications for these sets are being continually received, and several hundreds of them have already been supplied, a number of persons being occupied for a good part of their time in preparing to meet additional calls. There is nothing that so much increases the interest in natural history as the opportunity of examining actual specimens of rare and usually unprocurable species, instead of depending upon descriptions or drawings; and as the possibility of obtaining these series becomes the better known,

it is quite likely that all the resources of the Commission for making collections, great as they are, will be fully taxed.

The calls for these specimens are usually made through the member of Congress representing the district in which the institution is established; or if made directly to the Commission, they are referred to the member for his indorsement and recommendation.

Some noteworthy features of the year 1883 were as follows:

1. The completion of the Albatross and her arrival in Washington, March 24, fully equipped for service.

2. The use of the Albatross in studying the movements of schools of menhaden, mackerel, and other ocean fishes.

3. The use of the electric light by the Albatross in submarine explorations.

4. A request from prominent men of Great Britain connected with the International Fisheries Exhibition for an exhibit of the Albatross.

5. The loan of the Albatross, in compliance with a request of the Navy Department, for a cruise in the Caribbean Sea, the arrangements for which were completed during the year, although the cruise did not commence until January 4, 1884.

6. The employment of the Fish Hawk in hatching Spanish mackerel in the Chesapeake Bay.

7. The stranding of the Fish Hawk on Ocean Beach on the night of July 13, and her recovery, without serious damage, on July 18.

8. The transfer of land at Wood's Holl, on April 20, from trustees (representing the subscribers who furnished the purchase-money) to the United States, and the beginnings of the erection of building thereon.

9. The commencement and vigorous prosecution of work on the pier and breakwater at Wood's Holl, for which money was appropriated by Congress the preceding year.

10. The opening of the Great International Exhibition at London, May 1, and its closing on October 31, during which time a large exhibit was made by the U. S. Fish Commission, which attracted universal attention.

11. The continuance of the investigation of the ocean fisheries by a special committee of the United States Senate (Hon. E. G. Lapham, chairman), with the co-operation of the U. S. Commission, represented by Mr. Marshall McDonald, and including the use of the Fish Commission steamer Lookout.

12. The perfecting of an arrangement with the Life-Saving and Lighthouse Services whereby the keepers for the entire coast make telegraphic reports to the Commission of the stranded whales, porpoises, and other forms of marine life.

13. The hearty co-operation of certain railroad corporations in the work of distributing shad, carp, whitefish, &c., by transporting the Fish Commission cars free of charge. Notably among these were the Northern Pacific, which moved a car loaded with carp from Saint Paul to Portland, Oreg.; the Missouri Pacific, and the Atchison, Topeka and

Santa Fé, which carried a car from Saint Louis through Arkansas and Texas and back; the Flint and Père Marquette, which furnished many free trips for the cars containing whitefish; the Utah Central and various other companies.

14. The selection of a plan for a suitable fishway to be erected at the Great Falls of the Potomac, and the accomplishment of the preliminary surveys therefor.

15. The laying out of extensive experimental oyster-ponds at Saint Jerome Creek, Md.

16. The success of Mr. John A. Ryder in the artificial propagation of oysters at Stockton, Md.

17. The completion of an apron and other improvements at the Havre de Grace station.

18. The opening of the Cold Spring Harbor station by the New York State commission, and its use by the U. S. Commission.

19. The survey of the Columbia River and certain tributaries by Mr. Livingston Stone, with the view to finding suitable localities for salmon hatcheries.

20. The suspension of work at the McCloud River salmon station, the run of salmon having been seriously intermitted by the blasting necessary to the erection of the Northern Pacific Railroad along the river.

21. The increased production of whitefish at Northville and Alpena, Mich., fully 100,000,000 eggs having been taken.

22. The introduction of whitefish into Eagle Lake, Mount Desert Island, Maine.

23. The concerted action of the State fish commissions directly interested in the fisheries of the Great Lakes and the protection of those fisheries.

24. The occupation of Fort Washington, on the Potomac, for shad-hatching, permission having been granted by the Secretary of War.

25. The application of the method of transferring eggs of the shad to a distance, in a moist condition, on trays, it having heretofore been necessary to hatch the eggs at the stations and make the transfer of live fish to a distance.

26. Large run of shad in the Sacramento River, California, resulting from the introduction of young in these waters a few years since by the Fish Commission.

27. The great increase in productiveness of the inshore cod-fisheries, due to the general use of cod gill-nets which were introduced by the U. S. Commission.

28. The reappearance in Gloucester Harbor and at some other points of young cod, believed to belong to a school hatched at Gloucester in 1878.

29. Efforts to hatch cod in New York from eggs taken at Fulton Market.

30. The continued activity in the work of propagation and distribution of German carp.

31. The successful importation from Germany of the blue carp.

32. The discoveries by a Fish Commission agent, Mr. James G. Swan, in regard to the possibilities of an extended fishery on the Pacific coast for the black cod, and its indorsement by New York and Boston experts as a valuable food-fish.

33. The experiments of Mr. S. G. Worth in taking and hatching eggs of striped bass, or rockfish, which give promise of very valuable results hereafter.

A brief memorandum of what the U. S. Fish Commission hopes to accomplish in time, in connection with its mission, is as follows:

1. In the department of investigation and research there is yet to be carried out an exhaustive inquiry into the character, abundance, geographical distribution, and economical qualities of the inhabitants of the waters, both fresh and salt. The subject is practically unlimited in extent, and, so far as the ocean is concerned, has scarcely been touched. With the powerful apparatus, however, at the command of the Commission it is expected that much progress will be made year by year, and that the publication of the results and the distribution of duplicate specimens to colleges and academies in the United States will be carried out on a large scale, so as to meet a large and increasing demand from teachers and students.

2. A second object, in connection with the sea fisheries, is the improvement of the old methods and apparatus of fishing and the introduction of new ones.

The work of the Commission in bringing to the notice of American fishermen the importance of gill-nets with glass-ball floats for the capture of codfish has already revolutionized the winter cod-fishery industry in New England. Looked upon almost with ridicule by the Gloucester fishermen, when first brought to their notice by the Commission, these nets have come rapidly into use, until at the present time they represent the most important element in the winter fisheries, the number of fish taken being not only much greater than heretofore but the fish themselves of finer quality.

The ability to maintain a successful fishery without the use of bait is of the utmost importance, in view of the fact that when cod are most abundant bait is almost unprocurable. Other forms of apparatus of less importance have also been introduced, and a constant lookout is maintained, by correspondence and otherwise, in connection with the improvement of fishing machinery.

3. Another important point for consideration is that of improvement in the pattern of fishing vessels. There is annually a terrible mortality in the fishing crews of New England, especially those belonging to the port of Gloucester, to say nothing of the total loss and wreck of the fishing vessels and their contents. There has gradually developed in connection with the mackerel and cod fisheries of New England a pattern of vessel which, while admirable for speed and beauty of lines

and of rig, is less safe under certain emergencies than the more substantial and deeper vessel used abroad, especially in England and Scotland.

The subject of the best form of fishing-vessel has been intrusted to Captain Collins, of the Commission, himself a most experienced fisherman, and, after a careful study of the boats of all nations, he has prepared a model which is believed to combine the excellencies of both English and American vessels.

An appropriation will be asked from Congress for means to construct an experimental vessel and test its qualities; but until a successful experiment has been made it will be difficult to induce the fishermen to change their present form of construction.

4. The fourth object of the Commission is to determine the extent and general character of the old fishing localities and to discover new ones. There is no doubt whatever that there still remain many important areas, even in the best-known seas, where the codfish and halibut will be found in their former abundance. There has never been any formal investigation on this subject, and the banks that are known have been brought to light purely by accident. It is believed that by a systematic research and a careful survey the area of known grounds can be greatly extended.

There is very great reason to hope for successful results from this inquiry in the waters off the South Atlantic coast and in the Gulf of Mexico. These regions, the latter especially, may be considered as practically unknown, the few established localities for good fishing being in very small proportion to what must exist. It is here that the service of the fishing schooner referred to above, if means can be obtained to build it, will be brought into play, and it is not too much to hope that an industry will be developed that will represent to the Southern and South-western States the same source of income and occupation that the mackerel, cod, and halibut furnish to the fishermen of New England.

5. There is also much to be learned in the way of curing and packing fish for general and special markets. The American methods have grown up as a matter of routine, and are adapted to only one class of demand. There are, however, many modes of preparation which can be made use of to meet the wants of new markets; and thus we can enter more efficiently into competition with European nations for European trade, as well as for that of the West Indies and South America.

A great advance has already been made toward this desired improvement since the Centennial Exhibition of 1876, where many methods of curing and putting up fish were shown in the foreign sections that were almost entirely unknown in America. Notable among these were the preparations of sardines and other species of herring in oil, as well as in spiced juices. Quite recently this industry has been well established in Maine, amounting to a value of millions of dollars, and there are many other parts of the country where the same work can be done with other kinds of fish. The whole subject is receiving the careful consideration of the Commission, and numerous facts bearing upon it have been announced in its reports and bulletins.

6. The work of increasing the supply of valuable fishes and other aquatic forms in the waters of the United States, whether by artificial propagation or by transplantation, although very successful, may be considered as yet in its infancy.

It must be remembered that the agencies which have tended to diminish the abundance of the fish have been at work for many years and are increasing in an enormous ratio. This, taken in connection with the rapid multiplication of the population of the United States, makes the work an extremely difficult one. If the general conditions remained the same as they were fifty years ago, it would be a very simple thing to restore the former equilibrium.

At that time, it must be remembered, the methods of preservation and of wholesale transfer, by means of ice, were not known, while the means of quick transportation were very limited. Hence a small number of fish supplied fully the demand, with the exception, of course, of species that were salted down, like the cod, the mackerel, and the herring (including the shad). Now, however, the conditions are entirely changed. The whole country participates in the benefits of a large capture of fish, and there is no danger of glutting the market, since any surplus can be immediately frozen and shipped to a distance or held until the occurrence of a renewed demand.

Another impediment to the rapid accomplishment of the desired result is the absence of concurrent protective legislation of a sufficiently stringent character to prevent unnecessary waste of the fish during the critical period of spawning, and the erection or maintenance of impediments to their movements in reaching the spawning grounds. This is especially the case with the shad and the salmon, where the simple construction of an impassable dam, or the erection of a factory discharging its poisonous waste into the water, may in a few years entirely exterminate a successful and valuable fishery.

It is to be hoped that public opinion will be gradually led up to the necessity of action of the kind referred to, and that year by year a continued increase in the fisheries will be manifested. Even if this does not occur as rapidly as some may hope, the experiments so far furnish the strongest arguments in favor of continuing the work for a reasonable time. A diminution that has been going on for fifty or more years is not to be overcome in ten, in view of the increasing obstacles already referred to.

Among the species, an increase of which in their appropriate places and seasons is to be hoped for, in addition to those now occupying the attention of fish-culturists, are the cod, the halibut, the common mackerel, the Spanish mackerel, the striped bass, or rockfish, &c.

One of the most important, and at the same time among the most promising, fish is the California trout, with which it is hoped to stock large areas of the country. Its special commendations will be found mentioned elsewhere.

Another fishery earnestly calling for assistance, and capable of re-

ceiving it, is that of the lobster, the decrease of which has been very marked. The experiments of the Fish Commission suggest methods by which the number can be greatly increased. Something, too, may be done with the common crab of the Atlantic coast and its transfer to the Pacific. Some kinds might also be advantageously brought to the eastern portion of the United States from the Pacific coast and from the European seas.

A subject of as much importance as any other that now occupies the attention of the Fish Commission is an increase in the supply of oysters. In no department of the American fisheries has there been so rapid and alarming a decrease, and the boasted abundance of this mollusk on the Atlantic coast, especially in Chesapeake Bay, is rapidly being changed to a condition of scarcity which threatens practical extermination, as is almost the case in England. A fishing industry producing millions of dollars is menaced with extinction, and needs the most stringent measures for its protection.

The U. S. Fish Commission has been very fortunate, through its agents and assistants, in making important discoveries in connection with the propagation of the oyster, which are to be referred to hereafter; and it is proposed to establish several experimental stations for applying the discoveries thus made, so as to constitute a school of instruction and information to persons practically engaged in the business.

There are other shell-fish besides the oyster that will well repay the trouble of transplantation and multiplication. Among these are several species of clams belonging to the Pacific coast of the United States, which are much superior in size, in tenderness, and in excellence of flavor to those on the eastern coast. Most of these are natives of Puget Sound, and the completion of the Northern Pacific Railway is looked forward to as a convenient means of transferring them to Eastern waters. The common clams of the Atlantic coast are also fair subjects of experiment.

As might be expected, the correspondence of the Commission presents the usual increase in magnitude; requiring, of course, increased service in briefing, registering, filing, &c.*

** Table showing the number of letters received and written and the number of fish applications received by the U. S. Fish Commission during the fiscal year ending June 30, 1883.*

Months.	Letters registered.		Fish appli- cations reg- istered.	Total of letters and appli- cations.
	Received.	Written.		
1882.				
July	696	547	264	1,507
August.....	397	534	74	1,005
September.....	325	588	405	1,318
October.....	1,656	692	1,093	3,441
November.....	1,557	721	692	2,970
December.....	1,355	930	1,380	3,665
1883.				
January.....	1,501	1,121	905	3,527
February.....	1,514	1,050	774	3,338
March.....	1,620	1,073	859	3,552
April.....	1,572	1,046	784	3,402
May.....	1,102	786	199	2,087
June.....	1,057	828	505	2,390
Total	14,352	9,916	7,934	32,202

The Commission lost, by the death of Mr. Frank S. Eastman on March 12, an accomplished engineer and draughtsman, to whom it owed very much in connection with the planning and building of its fish-transportation cars.

Although not at the time an employee of the Commission, but as having formerly been in its service, it is proper to mention the death of Mr. O. M. Chase, on November 11. Mr. Chase, at the time of his death, was superintendent of the fish hatchery of the State of Michigan, at Detroit, and was engaged in collecting eggs of whitefish. Mr. Chase and a party of his employees, while crossing a bay in a small boat during a violent storm, were drowned by the upsetting of the boat. He was one of the most experienced fish-culturists of the country, having been trained by Mr. Seth Green, and having been in his employ, and also in that of the Fish Commission, before entering the service in which he met his death.

The three-story building No. 1443 Massachusetts avenue, which was leased in 1881, has continued to be occupied as an office by the Commission. The commissioner has, however, continued to use for himself and stenographer certain rooms in his private residence.

2.—PRINCIPAL STATIONS OF THE U. S. FISH COMMISSION.

These stations have been mentioned in previous reports, and a full explanation given of their general character. There are therefore simply enumerated in the present report to serve as a convenient table of reference. The special work accomplished at each station for the year will be given hereafter.

A.—INVESTIGATION AND RESEARCH.

1. *Gloucester, Mass.*—Capt. S. J. Martin, in charge of this station, continues his weekly reports of the products of the off-shore fisheries of that city, which have been collated and published from time to time in the Bulletins of the Fish Commission.

Captain Martin visits every vessel on its arrival and obtains the statistics of the catch during the voyage; and as there is no other organization for obtaining these data, his figures are largely used in the market reports of the Boston and Gloucester papers.

2. *Wood's Holl, Mass.*—This continues to be the headquarters of the Commission during the summer, and the chief locality for investigation and research. It is also the summer station of the vessels of the Commission.

The arrangements made for enlarging the work at this point will be more fully detailed hereafter.

3. *Saint Jerome, Md.*—This station is maintained for experiments in oyster culture and the hatching of marine fish, especially of the Spanish mackerel.

B.—PROPAGATION OF SALMONIDÆ.

4. *Grand Lake Stream, Me.*—The propagation of the landlocked or Schoodic salmon is carried on here on a large scale, under the direction of Mr. Charles G. Atkins.

5. *Bucksport, Me.*—The work of this station, also in charge of Mr. Atkins, is primarily connected with the multiplication of Penobscot salmon.

6. *Northville, Mich.*—This establishment is principally concerned in the hatching of whitefish, which are collected by Mr. F. W. Clark and his assistants, and at the proper time are either forwarded, in the condition of embryonization, to distant points, or entirely hatched out and the minnows transmitted to suitable localities. The station is also used for breeding the Eastern brook-trout and the California trout, of which a good stock is maintained. Two new trout ponds were completed in June.

7. *Alpena, Mich.*—This station was established in 1882 for the whitefish service, as being conveniently near the best localities for taking the eggs. It is kept as a feeder to the Northville station, which is the main one.

8. *Baird, Shasta County, California*—This station, on the McCloud River, is devoted exclusively to the cultivation of the California salmon, for which it is eminently adapted.

9. *Trout ponds near Baird, Shasta County, California.*—This locality, situated about 5 miles from the salmon station, is devoted to keeping up a large stock of California trout to supply eggs for eastern waters. The wild character of the region may be readily understood from the fact that the trout are fed on the meat of the black-tailed deer, as being the cheapest food that can be supplied to them.

10. *Wytheville, Va.*—In view of the expense attendant upon the transporting of the young Salmonidæ, such as California trout, brook-trout, landlocked salmon, &c., from Northville, Mich., and other stations, to distant points, especially the southern Alleghanies, it was concluded best to establish a station for hatching the same somewhere in the mountains of Virginia, as giving convenient access to the principal States having a water-supply fitted for the growth of such species. The Virginia fish commissioner had several years ago selected a locality near Wytheville, Va., as the most eligible spot known to him, and where an almost inexhaustible volume of cold spring water of the utmost purity was procurable. An arrangement was accordingly made to rent this station for the purpose in question, at a reasonable price; and a large number of eggs were sent there in the autumn of 1883, and successfully hatched out.

11. *Cold Spring Harbor, N. Y.*—For the purpose of hatching eggs of the salmon and of the whitefish for introduction into the rivers and lakes of Northern Pennsylvania, New York, and other adjacent States, arrangements were made to occupy, in part at least, the station of the

New York fish commission at Cold Spring Harbor, Long Island. This place is in convenient proximity to New York, and consequently enjoys excellent facilities for transportation and distribution. It is in charge of Mr. Fred Mather, who carries on simultaneously work for the State of New York and for the United States. Large numbers of salmon and other species have been successfully hatched out at this station and distributed to New York, Connecticut, and Pennsylvania.

Experiments will be made during the winter in the propagation of cod and tomcod at the Cold Spring Harbor station.

C.—PROPAGATION OF SHAD.

12. *Havre de Grace, Md.*—The work connected with the propagation of shad in their breeding grounds in the Susquehanna River, previously carried on by barges anchored in Spesutie Narrows, has been transferred to an artificial island known as Battery Island, which is a few miles below the railroad bridge at Havre de Grace. The facilities already established at this station were extended during the year, with the expectation of their yielding large results.

13. *Central Station, Washington, D. C.*—This station, established in the old Armory building, now constitutes an important point for hatching shad, herring, salmon, whitefish, and several other fish, and for their distribution by cars to distant parts of the country.

14. *Fort Washington, Md.*—This point was occupied this year for the first time, by permission of the War Department, and placed in charge of Lieut. W. C. Babcock, U. S. N.

D.—PROPAGATION OF CARP.

15. *Monument Reservation, Washington.*—This is the principal station for the production of carp. The varieties cultivated are the leather and mirror carp. Goldfish (*Cyprinus auratus*), golden ides, and tench are also raised in considerable numbers.

16. *Washington Arsenal grounds.*—Cultivation at this station is confined to the scale carp.

Fuller details in regard to the work and results of all these stations will be found under the head of the specific work for which they are maintained.

3.—NEW HATCHING STATIONS ASKED FOR.

1. *On the Columbia River.*—On January 18, 1883, Hon. J. H. Slater, United States Senator from Oregon, transmitted the following communication from the Astoria Chamber of Commerce, asking for the establishment of a salmon hatchery on the Columbia River or on one of its tributaries:

ASTORIA, OREG., December 29, 1882.

DEAR SIR: The Astoria Chamber of Commerce would respectfully ask for the establishment of a salmon hatchery by the General Government on the Columbia River or its tributaries.

It is expected that the railroad will be connected with the river, forming a continuous, uninterrupted line across the continent, before the month of August, 1883. and in time to distribute any spawn taken in that year.

The Columbia River salmon for distribution would be unequalled, while the restocking of the parent waters would be of great value.

The catch on the Columbia in 1882 was not less than 1,600,000 fish, and surely so great an industry and consumption needs fostering.

We exported from the Columbia River, in 1882, 540,000 cases, valued at \$2,900,000.

There are twenty-four salmon canneries now at Astoria and ten more within 30 miles, representing a permanently invested capital, in ground, buildings, machinery, &c., of at least \$850,000.

No other river in the United States produces so fine a quality of salmon (the Quin-nat); it is preferred in every market of the world, has more oil and a finer color and flavor, and commands an average of 15 per cent in price over the product of any other river.

Respectfully submitted by order of the Astoria Chamber of Commerce.

E. C. HOLDEN, *Secretary.*

Hon. SPENCER F. BAIRD,

U. S. Commissioner of Fish and Fisheries, Washington, D. C.

Subsequently Hon. M. C. George wrote requesting the Commission to do anything in its power to further the proposition. Accordingly Mr. Livingston Stone was directed to make a careful exploration of the river and its tributaries during the summer. His report and recommendations will be found in the appendix to this volume.

2. *At Milwaukee, Wis.*—On the 15th of January, 1883, a communication was received from Philo Dunning, president of the Wisconsin fish commission, transmitting a copy of some resolutions which had been adopted by the Wisconsin commission, and also a copy of a joint resolution of the State legislature of Wisconsin. On the 5th of February, Hon. R. D. Torrey, general manager of the Milwaukee Industrial Exposition Association, transmitted a resolution passed by the directors of the association making a similar request.

The common council of Milwaukee also passed a resolution of approval of the project.

The Fish Commission was unable to comply with these requests, as it had not the means for establishing additional hatcheries, and as those at Northville and Alpena furnished facilities for taking care of all the eggs obtainable in that region.

The resolutions and memorials referred to above were as follows:

At a regular meeting of the Wisconsin fish commission held on the 7th of January, 1883, the following action was taken with reference to the location of the Northwestern branch of the United States fish hatchery in Milwaukee:

Whereas we believe in the industry of the artificial propagation of the better classes of native and foreign fish, and recognize with satisfaction the efforts the General Government, under the efficient management of Prof. Spencer F. Baird, U. S. Commissioner of Fish, is putting forth in this direction; and

Whereas we believe no better place can be found than is offered in the city of Milwaukee, Wis., for the location of the Northwestern branch of the Government hatchery: Therefore,

Resolved, That we cordially invite Professor Baird to examine the facilities offered in this city, at an early day, with reference to locating said branch in this place.

XXVIII REPORT OF COMMISSIONER OF FISH AND FISHERIES.

Resolved, That a copy of this action be sent to Hon. P. V. Deuster, M. C., with the request that he present the same to Professor Baird and use his influence in carrying out the purpose thereof.

PHILO DUNNING,
President.

C. L. VALENTINE,
Secretary.

MILWAUKEE, January 7, 1883.

Resolved, That we, the board of directors of the Milwaukee Industrial Exposition, fully indorse the action of the Wisconsin State fish commission in their efforts to secure the location of the Northwestern branch of the Government fish hatchery in this city, and cordially invite Prof. Spencer F. Baird, U. S. Fish Commissioner, to visit Milwaukee and examine the conveniences offered in the exposition building for such purpose.

MILWAUKEE, January 8, 1883.

Extract of the action taken by the board of directors of the Milwaukee Industrial Exposition Association.

R. D. TORREY,
General Manager.

Joint resolution No. 1, S., inviting Spencer F. Baird to visit the State with a view to the establishment of a fish hatchery, &c.

Resolved by the senate (the assembly concurring), That Spencer F. Baird, U. S. Fish Commissioner, of the U. S. Commission of Fish and Fisheries, be, and he is hereby respectfully invited to visit Wisconsin, either personally or through an agent to be designated by him for that purpose, with the view to the establishment within this State of a United States fishery and hatching house for fish, at some suitable place to be approved by him; and that a duly certified copy of this resolution, attested by the chief clerks of the senate and assembly, be forthwith transmitted to said Spencer F. Baird, at the city of Washington, in the District of Columbia.

CHARLES E. BROSS,
Chief Clerk of the Senate.

I. T. CARR,
Chief Clerk of the Assembly.

4.—VESSELS OF THE U. S. FISH COMMISSION.

A.—THE STEAMER ALBATROSS.

The first year's work of this steamer has been very important and has fully met all reasonable expectations. During all of January and until the 10th of February she was at the Washington navy-yard, receiving apparatus and being put in condition for a cruise. It was found necessary, however, to return her to the shops of Pusey & Jones, at Wilmington, to make some alterations in the engines, which having been completed, the vessel started again for Washington on the 21st of March, arriving on the 25th. On the way several soundings and dredgings were made in from 82 to 641 fathoms. The vessel arrived at Washington March 25, the sounding and dredging apparatus having worked satisfactorily in these experimental tests, with the exception of the submarine electric light. On the 24th of April the vessel went to sea, under orders to investigate the conditions which govern the movements of the mack-

erel, menhaden, bluefish, and other migratory species, beginning off Hatteras and following up the schools in their movements. The physical conditions of the surroundings as to temperature and currents, as well as the chemical and biological peculiarities of the water, were also to be examined. The commander was directed to communicate with fishing vessels, in order to obtain information from them in regard to the movements of fish and their success in fishing. The dredging and trawling operations were to be carried on as frequently as opportunity offered. To what extent these purposes were attained may be seen by examination of the report of Lieutenant-Commander Tanner, U. S. N., in the appendix.

On the 31st of May the vessel went into the dry-dock at the Brooklyn navy-yard, where the magnetic survey of the vessel, which had been begun in April, was completed by Lieutenants Wainwright and Diehl, U. S. N., under direction of the Navy Department. She left New York on the 8th and arrived at Washington on the 19th of June. Preparations were then made for the summer cruise, which was commenced July 6, under orders quite similar to those of the previous trip. Capt. Jacob Almy, of New Bedford, accompanied the ship as a fisherman expert. During this cruise a large number of reports relating to the mackerel and menhaden fisheries were obtained from fishing vessels and factories, which will be found in Captain Tanner's report in the appendix. The Albatross ran into Wood's Holl on July 14, and left two days later, with a number of naturalists on board, for a dredging trip along the edge of the Gulf Stream. July 20th she went to Newport for coal, and returned to Wood's Holl on the 24th. From July 25 to August 1 was spent in dredging trips, during which many successful hauls were made. On the 6th of August the investigation of the menhaden and mackerel fisheries was resumed. The vessel proceeded by way of Newport to Block Island, No Man's Land, and the coast of Long Island. But very few fish were seen on this trip. She returned August 10, and on the 20th started out again in search of mackerel in the region about Nantucket, George's Banks, Cape Sable, Grand Manan, &c., returning to Wood's Holl September 6. During the various trips many fishing vessels were met with, and valuable statements obtained from them by Captain Almy, the substance of which is given in Captain Tanner's report.

Having taken coal at New Bedford, and made necessary repairs, the Albatross again started off on the 19th of September, for the purpose of making another examination of the tilefish grounds. The party returned on the 22d, having taken one swordfish and several kinds of smaller fish, but no tilefish. Between September 29 and October 5 a successful dredging trip was made to the Gulf Stream. Having coaled at Newport on the 12th of October, Captain Collins was taken on board as expert fisherman in place of Captain Almy, whose term of service had expired, and another cruise was then made for the pur-

pose of investigating the migrations of mackerel and menhaden. The vessel proceeded to Block Island, Barnstable Bay, Boston Bay, Gloucester Harbor, and returned southward by Stellwagen Bank, No Man's Land, and Sandy Hook. A call was made at the Brooklyn navy-yard to obtain coal and provisions. The vessel then cruised southward as far as Cape Hatteras, and entering the Chesapeake, arrived at Washington November 13. From this time until the end of the year the vessel was at the navy-yard refitting for a winter cruise. In the reports of Capt. J. W. Collins, Capt. Jacob Almy, Mr. James E. Benedict, Ensign R. H. Miner, U. S. N., Surgeon C. G. Herndon, U. S. N., Engineer G. W. Baird, U. S. N., and Lieut. Seaton Schroeder, U. S. N., all of which are embodied in the report of the commander and contained in the appendix, will be found the details of the several cruises and an epitome of the work accomplished.

The *personnel* of the steamer during the year consisted of —

Lieut.-Commander Z. L. Tanner, U. S. N., commanding officer.

Lieut. Seaton Schroeder, U. S. N., executive officer and navigator, in charge of hydrography and meteorology.

Lieut. Sidney H. May, U. S. N., watch officer, in charge of sounding apparatus.

Lieut. A. C. Baker, U. S. N., watch officer, in charge of dredging apparatus.

Ensign Clifford J. Boush, U. S. N., watch officer, in charge of electric apparatus.

Ensign R. H. Miner, U. S. N., recording officer, in charge of marine vertebrates.

Surgeon Jerome H. Kidder, U. S. N., medical officer, in charge of chemistry.

Paymaster George H. Read, U. S. N., pay officer, in charge of photography.

Passed Assistant Engineer George W. Baird, U. S. N., chief engineer, in charge of special mechanical appliances.

James E. Benedict, resident naturalist.

By direction of the Secretary of the Treasury, the collector of customs at Wilmington, Del., reported as follows in regard to the measurements of the Albatross :

Register length	feet..	205.00
Register breadth	feet..	27.50
Register depth	feet..	16.50
Measurement	tons..	385.88
Gross tonnage	tons..	638.82

This may be a suitable place to mention the fact that a model of the Albatross, furnished by Pusey & Jones, excited much interest at the London Exhibition, and a great desire was expressed to have the vessel herself sent there, in order that her many special and interesting peculiarities might be examined. It was, however, not considered expedient

to withdraw the vessel from her field of duty, as the extra expense could not be spared from the London Exhibition appropriation; neither could the cost of coal and other necessary expenses that would have been involved, be paid by the Fish Commission.

The Navy Department, through Commodore Walker, chief of the Bureau of Navigation, made application for the services of the Albatross in connection with the taking of soundings and other investigations in the Caribbean Sea, with the understanding that the expense of maintenance and repair of the vessel during the period of its transfer was to be assumed by the Navy Department. This was assented to, and preparations were duly made towards the end of the year. As, however, the cruise itself was made in the subsequent year, the report of 1884 will contain the details.

In a special report by Captain Tanner upon the construction of the Albatross and her operations for the year will be found many details of great scientific and practical interest. A full account is also given of the system of electric lighting, by Engineer G. W. Baird.

B.—THE STEAMER FISH HAWK.

This vessel remained during the entire year under the command of Lieut. William M. Wood, U. S. N. She was at the Washington navy-yard until March 15, when a trip was made to the Chesapeake, in search of the sperm whale reported ashore at Smith's Point, Virginia. The whale was not found, but the fisheries at Marlborough and Brent's Points were examined. A few shad and herring and quite a number of rock, perch, &c., were being taken.

On the 24th of March the Fish Hawk again left Washington, with a lot of material for Havre de Grace station. The vessel reached that point the next day, having called at the Saint Jerome station on her way. After coaling at Baltimore she proceeded to Saint Jerome and dredged for oysters a few hours. On the morning of the 1st of April she returned to the Washington navy-yard. On the 12th of April Lieutenant Wood sailed for Shipping Point, on the Potomac, with orders to commence the hatching of shad, herring, and rockfish, collecting eggs in that region of the river south of Gunston's Cove. The fisheries were found to be in successful operation, but it was some days before the fish were ripe enough to furnish suitable eggs for propagation. During the first ten days the temperature was very low, and over 7,000,000 herring eggs were lost by sudden changes of temperature. On the 7th of May the vessel was moved to Glymont, where the water was found to be both clearer and warmer. Nine hundred thousand herring and 60,000 perch eggs were taken the first day. The taking and hatching of eggs was continued at this point until about the 25th of May, when the vessel returned to Washington.

She was then ordered to prepare to sail June 4 for the mouth of the Chesapeake, and on the way to locate upon charts the pound-nets and

to report their season's work, names of owners, amount of fish taken, &c., both on the Potomac and in the Chesapeake. Lieutenant Wood was further directed to examine various points with a view to propagating Spanish mackerel and the oyster. The vessel arrived at Fairport, Va., on this mission June 6, and at Cherrystone, Va., June 12, which terminated this part of the investigation. An abstract of the information obtained concerning the pound-nets in the Potomac will be found in the Fish Commission Bulletin for 1883, pages 278-280. A call was made at Hampton upon Professor Brooks, who was found at his laboratory experimenting upon oysters.

The vessel arrived at York Spit June 18, and commenced prospecting for Spanish mackerel. On the 21st the first ripe spawn was obtained, and the vessel was continuously engaged in this work until the 3d of August. An account of the work and of some new apparatus which was employed will be found in two papers in the appendix, one by Lieutenant Wood and the other by Dr. J. Alban Kite.

On the 13th of July the vessel was anchored off Ocean Beach, near Hampton Roads. That evening a sudden heavy storm caused the vessel to drag her anchor and blew her ashore. Assistance was obtained on the 14th from the Baker Wrecking Company, of Norfolk, and at different times from the Army tug Monroe, the U. S. S. Pinta, the tug Snowdrop, the revenue-cutter Ewing, and the lighthouse tender Holly. At 5 a. m. on the morning of July 18 the ship was floated. Fortunately it was found that but little injury had been done.

On the 5th of August the vessel was coaled in Baltimore, and on the 13th an unsuccessful attempt was made to get some more Spanish mackerel eggs. After being delayed at Hampton by bad weather until the 17th Lieutenant Wood proceeded, by way of Sandy Hook and Hell Gate, to Wood's Holl, where he arrived on the evening of August 20. On the 22d the vessel sailed for a trawling trip to the edge of the Gulf Stream. Several stations were made, and the vessel returned to Wood's Holl on August 24.

The Decatur H. Miller, of the Merchants and Miners' Transportation Line, being reported ashore in Vineyard Sound September 23, Lieutenant Wood immediately went to her assistance, finding already there the Coast Survey steamer Blake and the revenue steamer Dexter. By their joint action the vessel was floated the same evening. The services of the Fish Hawk in connection with the relief of the Decatur H. Miller were formally acknowledged by the secretary of the company.

The Fish Hawk remained with headquarters at Wood's Holl until October 16, when she took on board certain freight for Washington. Having called at Newport to coal and at New York for provisions and stores and 100 live lobsters to be deposited in Chesapeake Bay, she arrived at the capes October 27 and at Washington on the 30th. An account of the transfer and successful plant of the lobsters near Fort Wool will be found in the Bulletin for 1884, page 16.

The next work assigned to the Fish Hawk was that of laying out oyster-ponds at Saint Jerome station, for which purpose she left Washington November 12, and arrived at Saint Jerome the next day. An account of the dredging and of the laying out of three oyster-ponds will be found in the appendix to this report. The vessel returned to Washington November 26, where she remained until the close of the year.

A renewed measurement of the tonnage of the Fish Hawk was made under order of the Treasury Department, the figures being 441.40 tons gross measurement and 205.1 tons net measurement; signal letters G. V. Q. C.

The officers during the year were as follows:

Lieut. W. M. Wood, U. S. N., commanding officer.

James A. Smith, mate and executive officer.

D. H. Cleaveland, mate.

William L. Bailie, passed assistant engineer, acting chief engineer.

J. Alban Kite, M. D., civilian, apothecary.

C.—THE LOOKOUT.

The steamer Lookout, belonging to Mr. T. B. Ferguson, and used by the Fish Commission since 1878 without any compensation to the owner, has continued to render excellent service in the operations of the Commission, partly in transporting supplies between Washington and the stations at Saint Jerome and Havre de Grace, and partly in close relationship with the propagation of shad, Spanish mackerel, and oysters.

As stated in the previous report, Lieutenant Wood having been transferred to the command of the Fish Hawk on the 20th of November, 1882, the command of the Lookout devolved upon Chief Quartermaster William Hamlen, whose long service with the Fish Commission and zealous performance of his duties warranted his being continued in this responsible position during the year, especially as on so small a vessel proper accommodations for a naval officer of rank could not be provided.

Soon after the change in the command of this steamer she was transferred from the head of the Chesapeake Bay to the Washington navy-yard, and Mr. Hamlen was detached temporarily to conduct some experiments in hatching codfish at Fulton Market, New York City.

Towards the end of February, the vessel having been equipped for a southern cruise, Lieut. Francis Winslow was instructed to make some investigations as to the oyster-beds of the Potomac River and Chesapeake Bay while the steamer was on the way to Norfolk. On the 3d of March she sailed from Norfolk to Charleston, by the inland route, and arrived at Beaufort, N. C., on the 6th, where she was storm-bound until the latter part of the month.

The collector of customs, by direction of the Secretary of the Treasury, caused her to be measured while she was at Charleston, and re-

ported her gross tonnage 54.49, net tonnage 28.76; and signal letters G. V. Q. D. were assigned her.

On the 19th of that month she was joined at Charleston by Assistant Commissioner T. B. Ferguson, who proceeded to Florida for the purpose of investigating the condition of the shad fisheries on the Southern Atlantic coast, with a view of establishing hatching stations. Extracts from Mr. Ferguson's report on this inspection will be found on page 244 of the fourth volume of the Fish Commission Bulletin (1884). The Lookout returned to Charleston on the 2d of April, the investigations in the more southern waters having been hurriedly made on account of being due at Washington to report for work on the Potomac and Susquehanna Rivers.

She arrived in Washington on the 19th, but having been run into by a schooner in the narrow channel near the navy-yard, she was sent to Baltimore for repairs, which were completed by the 2d of May. She was immediately transferred to the Potomac River, where she materially aided in the prosecution of the shad-hatching operations in that locality.

During the month of June she was employed as a dispatch boat in making inspections of the Saint Jerome and Battery stations; but, unfortunately, on the 30th of the month, while proceeding down the Potomac, her shaft broke. This accident deprived the Commission of her services until the necessary repairs could be made. Secretary Chandler having given instructions for the repairs to be promptly made at the Washington navy-yard, they were completed by the 11th of July, and on the following day she sailed for the Lower Chesapeake, and was employed during the rest of the month in hatching the Spanish mackerel and investigating the oyster-beds in that region.

In September she was utilized for transferring flumes, to be used in the oyster-ponds, from Saint Jerome station to Norfolk, to be treated with preservatives.

This service was intermitted by the transfer of the vessel for a time to the subcommittee of the Senate Committee on Foreign Relations, Senator Lapham, chairman, which was engaged in making inquiries into the condition of the menhaden fisheries of the Chesapeake. On the completion of this work she resumed the transfer of the lumber between Saint Jerome and Norfolk, and then returned to Washington.

After a short stay she was again employed in connection with the Saint Jerome station during November.

At the close of the year the Lookout was laid up at the Washington navy-yard to undergo repairs and some alterations for the purpose of better adapting her to the varied services which she might be called upon to perform.

D.—LAUNCHES.

The only launch actually belonging to the miscellaneous service of the Commission, Herreshoff, No. 82, was in constant service during the

year. In the spring she served as a tender to the work of fish propagation at Battery Station, and in the summer she was used in connection with the marine investigations at Wood's Holl. By reason of her general seaworthiness, she was able to proceed without convoy to the New England coast, and to return without any damage.

The other launches, belonging to the Navy Department, were also in constant use and kept in thorough repair by the Commission.

E.—THE CANVAS-BACK.

In a previous report reference was made to a small light-draft steamer, which it was considered desirable to have for service in laying out the seine over the shoal waters at Battery Station. Although such a vessel would have been very desirable, no appropriation was available for its construction, and the project remains in the same condition as last year.

F.—PROPOSED FISHING SCHOONER.

Reference has been made in previous reports to the project of having a schooner constructed with a well, in which living fish might be transported from place to place, to be used more especially as a tender to the Wood's Holl station in bringing in living codfish, halibut, and other species from distant points, to be kept in basins until the eggs were ripe for removal. Such an appendage is deemed absolutely necessary to the proper working of the Wood's Holl establishment.

Capt. J. W. Collins, one of the assistants of the Fish Commission, and who for many years has been a highly successful practical fisherman of Gloucester, was directed to prepare a model, drawings, and specifications of a suitable vessel that should contain, as far as possible, all the best qualities of the fishing service of both America and Europe, and serve as a suitable mean between the comparatively shoal schooners used in the United States and the deeper draft of the European smack. Well fitted by his previous experience, he utilized his attendance upon the Berlin Fishery Exposition in 1880, and that of London in 1883, to solve the problem submitted to him; and a model which the U. S. Fish Commission exhibited at London was highly approved by those who were competent to criticise and judge. It is hoped that Congress may at an early date furnish the means for building such a vessel, and not only aid the Commission in carrying out its work, but also in supplying a pattern for imitation by the fishermen.

Very few persons realize the annual loss of property and life incurred in connection with the fishing fleet of New England, especially off George's Banks, which are not improperly called "Gloucester's graveyard." There has been for many years an average destruction of 10 vessels and the loss of 100 lives; sometimes the figures are considerably larger. These vessels, for the most part, founder and disappear entirely, without leaving any trace behind or any suggestion as to the actual causes of their destruction.

5.—FISH HATCHING AND TRANSPORTATION CARS.

Reference has been made in previous reports to the important service rendered the Commission by its two cars.

Of these, No. 1 consisted of a first-class baggage car formerly belonging to the Philadelphia, Wilmington, and Baltimore Railroad Company, fitted up for the required service. It is 51 feet 2 inches long, without platform; with platform, 57 feet 6 inches; total height from the track to the topmost projection, 14 feet 1½ inches; total width, 9 feet 10 inches.

The experience gained by using this car was subsequently utilized in the construction of a second car for the Commission by the Baltimore and Ohio Railroad Company, and which contained many important improvements upon the work of car No. 1.

The dimensions of car No. 2 are 59 feet 9 inches in length between the outer ends of the buffers; height, 14 feet 7⁄8 inch from the top of track to top of hood; width, 10 feet.

The efficiency of these cars and the service rendered by them in the work of the Commission, both in the transportation of young fish and in the hatching of eggs, render a third very desirable. Plans for this have been prepared, and will be applied in the event of an appropriation for the same being granted by Congress. Details in regard to the uses made of these cars during the year will be found in the report of the distribution division. It may, however, be interesting to learn that car No. 1 traveled during the year 31,993 miles in the distribution of carp, salmon, and shad. The number of shad distributed was 6,715,000; of herring, 5,550,000; of carp, 113,605; and of salmon, 450,000.

6.—COURTESIES EXTENDED TO THE U. S. FISH COMMISSION.

A.—BY THE GOVERNMENT.

As in previous years, I have the pleasure of acknowledging many important courtesies extended to the Commission by the various Departments of the Government, by railroad and steamboat companies, and by individuals. Indeed, without the help thus rendered it would be quite impossible to carry on the work on its present scale without a very considerable increase in the appropriations.

TREASURY DEPARTMENT.—*Secretary's Office.*—Mr. Hobbs was authorized by the Secretary of the Treasury on the 8th of August to disburse the appropriation for the Wood's Holl buildings.

Light-House Board.—The Light-House Board, May 28th, authorized the further use of the storage building at Wood's Holl previously occupied by the Commission. Instructions were given to the inspector of the second light-house district to place a mooring for the Albatross in Great Harbor, Wood's Holl, Mass. The Light-House Board has continued to assist in taking ocean temperatures at about thirty-five of the light-houses and light-ships most favorably located.

Coast Survey.—It has been found necessary to call frequently upon the Coast Survey for tide-tables, maps, and charts required for the use of the different vessels of the Fish Commission, which have always been promptly furnished.

Life-Saving Service.—In connection with the propagation of codfish in the vicinity of New York, certain life-saving crews were directed to aid the employees of the Fish Commission.

The arrangement made by the Superintendent of the Life-Saving Service, early in the year, for the telegraphic announcement to the Smithsonian Institution of the stranding of marine animals has already been productive of important results. The series of specimens thus far received is in every way remarkable, and should the system continue to be so productive it is impossible to say what good may not result to zoology. The first specimen received was that of a shark (*Pseudotriacis microdon*) from Station No. 10, Amagansett, N. Y., Mr. Joshua B. Edwards, keeper. This species had hitherto been captured only off the coast of Portugal, and its discovery in our waters was a matter of great interest to American ichthyologists. The only other specimen known to be preserved is the type of the species.

Shortly after this shark was received a still more remarkable animal was announced from Station No. 8, at Spring Lake, N. J., Mr. Henry S. Howland, keeper. This was a pigmy sperm-whale of the genus *Kogia*, a form entirely new to the North Atlantic. Few specimens of this genus have ever been collected, and these from the most remote parts of the globe, some from New Zealand, and one from Mazatlan, at the entrance of the Gulf of California. These animals resemble the great sperm-whale, to which they are closely related, but do not seem to attain a length of more than 9 or 10 feet, and are truly the pigmies of their race. The New Jersey specimen was peculiarly interesting in that it was a female with young. In dissecting the animal a fetus fully 3 feet long was found, which is probably the first ever seen by the naturalist.

The interest aroused by the arrival of this specimen had scarcely abated when the stranding of another cetacean was announced from Station No. 17, at Barnegat City, N. J., Mr. J. H. Ridgway, keeper. This remarkable animal floated in upon the tide and was secured by Mr. Ridgway and his crew after considerable exertion. The curator of mammals and an assistant were dispatched from the National Museum, and a cast of the exterior was made and the skeleton prepared for shipment to Washington. As the huge animal lay upon the sand the question of its identity proved quite a puzzling one to the zoologist who viewed it; but when the skull was cut out, it was at once apparent that the animal belonged to the whales known as the Ziphioids, and probably to the species *Ziphius cavirostris*, an animal for which no common name exists, but which may be termed a bottle-nose whale. It is probably the second specimen ever taken on the coast of the United States.

Ziphioid whales have a most interesting history. In ages past they were very abundant, perhaps as much so as the common porpoise of to-day, but at present only stragglers are found in remote quarters of the globe. It would seem as if they were but the surviving relics of a great race, which sprang into existence, reached the maximum of its abundance, and declined long ages before man appeared on the earth. Many species occur as fossils in connection with the phosphate deposits of South Carolina.

From Station No. 20, at Fire Island, N. Y., Mr. Daniel S. Hubbard, keeper; and Station No. 37, at Turtle Gut, N. J., Mr. Uriah Gresse, keeper, came two specimens of a porpoise, which, unlike the cetaceans which have been already referred to, is of common occurrence on our Atlantic coast, and is probably also represented in European waters. The casts, however, which the National Museum was enabled to make are probably the first of the species in any museum in the country, and, with the skeletons, which were preserved, form an excellent basis for comparison with other forms. The animal is commonly known as the bottle-nose dolphin, and is identical with or closely allied to the species *Tursiops truncatus*.

In addition to the shark previously mentioned, several peculiar and interesting fishes have been received. Among these is a fish known as the "star-gazer" (*Astroscopus anolophus*), from Station No. 6, at Deal's Island, N. C., Mr. Malachi Corbel, keeper. The "star-gazer" is a southern species which occasionally strays northward as far as Cape Cod, but it is very rare in museums. A very closely allied species (*anolophus* var. *græcum*) is said to possess electrical power in life. From Station No. 2, at Point Judith, R. I., Mr. Herbert M. Knowles, keeper, was received a specimen of the "lumpfish." The "lumpfish" (*Cyclopterus lumpus*) as a rule is an inhabitant of colder waters than that in which it was found. The "flute mouth" (*Fistularia serrata*), from the same station, is a very rare species on our coast. The "angel fish" (*Pomacanthus arcuatus*), taken at Barnegat City, N. J., has not hitherto been known north of Florida.

WAR DEPARTMENT.—Permission was given May 28th, by the Acting Secretary of War, for one of the steamers to land at the Arsenal wharf, and to occupy it whenever not engaged at the fisheries.

Engineer Bureau.—March 23d the Chief of Engineers, General H. G. Wright, granted permission to use the fishing-shore at Fort Washington for the purpose of propagating shad, with the understanding that the grounds should be vacated whenever the Department should so request. Subsequently a like permission was granted to use one of the buildings at the fort as headquarters for the men.

The Bureau furnished maps of the Columbia River, to be used in the tour of exploration by Mr. Livingston Stone.

Signal Office.—General Hazen furnished weather indications to the Lookout on the trip to South Carolina in the spring, and also sent

weather telegrams to Wood's Holl during the summer season. He also replaced several broken thermometers for the use of lighthouse keepers in taking temperature observations.

NAVY DEPARTMENT.—The officers and crews of all the vessels of the Fish Commission have been furnished by the Navy Department during the year, and all the facilities of the navy-yards, particularly that at Washington, have been extended.

Bureau of Construction and Repair.—March 22d the chief of this Bureau authorized the continued use of Navy launches Nos. 55 and 49. May 16th the chief of this Bureau gave instructions to the commandants at New York and Norfolk to dock and paint the Albatross.

Bureau of Equipment and Recruiting.—April 13th Commodore English authorized the detail of machinist, fireman, and seaman for the new launch. April 16th Commodore English authorized the commandants of the navy-yards at Boston, New York, Norfolk, and Washington, and the Superintendent of the Naval Academy at Annapolis, to furnish coal to Fish Commission vessels upon requisition. January 4th, at the request of Captain Tanner, an exchange of galleys was made between the Albatross and the Wyandotte.

Bureau of Ordnance.—April 13th the Bureau furnished a 3-inch breech-loading howitzer for the Albatross; also small-arms for the Albatross, and powder-tanks for use in making collections of specimens.

Naval Constructor Pook rendered assistance in making drawings for a fishing smack.

POST-OFFICE DEPARTMENT.—This Department established a post-office at the McCloud River salmon station, naming it Baird; and Mr. Radcliff was appointed postmaster January 18.

INTERIOR DEPARTMENT.—*Patent Office.*—The Commissioner of Patents has supplied the Commission with the Official Gazette, and other information with reference to patents relating to fish and fisheries apparatus.

B.—BY THE RAILROADS OF THE UNITED STATES.

In the earlier years of the work of the Commission the distribution of eggs and young fish was made in the baggage cars of the ordinary passenger trains, the special privilege being granted of having the fish carried without extra charge, and free access allowed to them on the part of the messengers of the Commission. The value of this concession may be readily understood from the fact that the equipment usually consisted of ten or twelve cans of 10 or more gallons capacity each, and requiring, of course, a large amount of standing room, and involving a great deal of wetting of the floor.

Nearly all the railroads in the United States cordially assented to this condition, an official circular being obtained from each one, which was carried by the messengers and presented on occasion. So hearty was the co-operation of the roads with this enterprise that cases were

not wanting where important freight was left behind in order to permit the fish to be carried through without detention.

Since the introduction, however, of transporting cars, this method of distribution has been very largely given up, being now employed only for service of localities within a few hundred miles of Washington.

While some railroads carried these cars free of any charge whatever, most of the others have exacted only a very trifling sum, generally 20 cents per mile for the car and five messengers, any additional number of messengers, when required, paying regular fares. The principal roads charging the twenty cents per mile, or thereabouts, are as follows:

Alabama Great Southern Railway; Chattanooga, Tenn.
 Atchison, Topeka and Santa Fé Railroad; Topeka, Kans. (In part only. See below.)
 Atlanta and West Point Railroad; Atlanta, Ga.
 Baltimore and Ohio Railroad; Baltimore, Md.
 Chesapeake and Ohio Railway; Richmond, Va.
 Chicago and Northwestern Railway; Chicago, Ill.
 Chicago, Burlington and Quincy Railroad; Chicago, Ill.
 Chicago, Milwaukee and Saint Paul Railway; Chicago, Ill.
 Cincinnati, Indianapolis, Saint Louis and Chicago Railway; Cincinnati, Ohio.
 Columbus, Hocking Valley and Toledo Railroad; Columbus, Ohio.
 East Tennessee, Virginia and Georgia Railroad; Knoxville, Tenn.
 Georgia Railroad; Augusta, Ga.
 Illinois Central Railroad; Chicago, Ill.
 Louisville and Nashville Railroad; Louisville, Ky.
 Marietta and Cincinnati Railroad (now Cincinnati, Washington and Baltimore); Cincinnati, Ohio.
 Minneapolis and Saint Louis Railroad; Minneapolis, Minn.
 Nashville, Chattanooga and Saint Louis Railway; Nashville, Tenn.
 New York and New England Railroad; Boston, Mass.
 New York, New Haven and Hartford Railroad; New York, N. Y.
 Pennsylvania Railroad; Philadelphia, Pa.
 Pennsylvania Company:
 Jeffersonville, Madison and Indianapolis Railway; Louisville, Ky.
 Pittsburg, Cincinnati and Saint Louis Railway.
 Pittsburg, Fort Wayne and Chicago Railway.
 Petersburg Railroad; Petersburg, Va.
 Raleigh and Gaston Railroad; Raleigh, N. C.
 Richmond and Danville Railway; Richmond, Va.
 Richmond and Petersburg Railroad; Richmond, Va.
 Richmond, Fredericksburg and Potomac Railroad; Richmond, Va.
 Terre Haute and Indianapolis Railroad; Terre Haute, Ind.
 Virginia Midland Railway; Alexandria, Va.
 Western Railroad of Alabama; Montgomery, Ala.

The following roads performed this service free, except the Saint Louis, Keokuk and Northwestern, which made a charge of 10 cents per mile:

Missouri Pacific Railroad.
 Saint Louis, Keokuk and Northwestern Railway.
 Atchison, Topeka and Santa Fé Railroad.
 Flint and Père Marquette Railway.
 Utah Central Railroad.
 Northern Pacific Railroad.

The Northern Pacific Railroad issued a free pass for Mr. Livingston Stone to traverse that line during his explorations of the Columbia River with a view of establishing a salmon hatchery.

C.—BY FOREIGN STEAMSHIP COMPANIES.

In addition to the companies that have heretofore rendered facilities, Messrs. Peter Wright & Sons, general managers of the Red Star Line, have offered to carry fish to Liverpool free of charge.

D.—BY FOREIGN COUNTRIES.

Germany.—Several attempts were made by Herr von Behr to send some of the blue carp of Germany. During January a shipment of eight arrived to the care of Mr. Blackford, who forwarded them to Washington, but most of them died, having suffered from fungus and bruises. On May 8th, five were received in good condition from the *Deutsche Fischerei-Verein*, the survivors of forty which had been forwarded by Mr. Busse, of Geestemünde.

7.—COURTESIES TO FOREIGN COUNTRIES.

Nearly every year of the Fish Commission's existence eggs or fish have been sent to foreign countries in response to properly authenticated requests. Within the present year a larger number of applications have been made than usual. This has been caused, perhaps, by the success which has heretofore largely attended shipments abroad.

France.—On the 3d of January 200,000 whitefish eggs and 50,000 lake-trout eggs were placed on the steamer Labrador for transmission to the Society of Acclimation in Paris, where they arrived in perfect condition.

On the 6th of February 20,000 brook-trout eggs from the station at Northville were shipped from New York by steamer St. Laurent. Receipt of these in perfect condition was acknowledged by the society under date of March 3.

March 7th, 15,000 landlocked salmon eggs were forwarded by steamer to the same society. These are reported to have arrived in perfect condition March 31st. An illustration of the results of the efforts to acclimatize California salmon in France will be found in the Fish Commission Bulletin for 1884, page 138, from which it appears that at three different times salmon measuring from 25 to 30 centimeters in length have been taken in the river Aube, which were no doubt results of eggs sent by the U. S. Fish Commission in 1879, 1880, and 1881.

Germany.—On Saturday, January 6th, there were forwarded by a North German Lloyd steamer 25,000 brook-trout eggs, 100,000 lake-trout eggs, and 500,000 whitefish eggs. These were all for the *Deutsche Fischerei-Verein*, and were sent to the care of F. Busse, Geestemünde. Under date of January 19th, Herr von Behr announced the safe arrival of the whitefish eggs and the brook-trout eggs, but that, as many of the lake-trout eggs hatched out on the way, only about 30 per cent of

the lake-trout lot could be saved. On the 10th of March 25,000 landlocked salmon eggs were sent to the *Deutsche Fischerei-Verein* by steamer Neckar. Under date of April 1, Herr von Behr wrote that the landlocked salmon eggs "arrived in wonderful condition."

In February Mr. George Eckardt undertook to carry 7 large-mouth and 45 small-mouth black bass with him to Germany, and he arrived safely with the bass February 27. He delivered them to Max von dem Borne, at Berneuchen. Subsequently a large proportion of the fish died, probably in consequence of the long journey; but 3 of the former and 10 of the latter survived the winter of 1883-'84. The large-mouth bass spawned in the spring of 1884, and more than 2,000 young were obtained. Three of the old ones had grown very rapidly by this time, and measured more than 12 inches in length.

Great Britain.—On the 2d of February 10,000 brook-trout eggs were sent by Cunard steamer Catalonia to the Norfolk and Suffolk Acclimatization Society, of which Hon. W. Oldham Chambers is secretary. Under date of February 26th he reported their arrival in excellent condition.

On March 7th, 10,000 landlocked salmon eggs were forwarded by Cunard steamer Bothnia to the same address. Under date of April 6 the safe arrival of these eggs was announced. They also hatched with very small loss.

Belgium.—Application having been made by Hon. E. Williquet, of Ghent, for catfish, several efforts were made to forward them, but, the specimens offered being unsuitable, further efforts were deferred until another year. The White Star Line to Antwerp, Peter Wright & Sons, general managers, kindly offered to transmit the catfish free of charge.

Cuba.—Two large cans containing 26 carp were forwarded by steamer Newport from New York to Mr. Odvards, Havana, Cuba. Under date of March 17 he reported that 3 of them died during the trip and 7 after arrival, and that the remainder were in good condition.

Brazil.—Under date of January 6, Mr. J. W. Couchman, of Rio Janeiro, reported the safe arrival of 13 carp out of 100 that had been forwarded thirty-nine days previously from New York by the steamer Borghese.

United States of Colombia.—On the 14th of January Don Ricardo Becerra, of Bogota, received at New York 6,000 brook-trout eggs and 100 carp, which he took home with him to Bogota.

Mexico.—On the 25th of January there were forwarded to Mr. Blackford, New York, 50 carp, to be sent by the New York and Mexican Steamship Line to A. B. Clark, San Luis Potosi, care of Messrs. D'Oleire & Co.'s Successors, Vera Cruz, for Eugene Pigeon, San Luis Potosi.

8.—THE LONDON AND OTHER FISHERIES EXHIBITIONS.

In a previous report mention is made of the passage of an act by Congress authorizing and directing the participation by the United

States, through its Fish Commission, in the London International Fisheries Exhibition of 1883.

The preparations, begun in July, 1882, were carried on with great activity, and on the 26th of February a preliminary exhibition of such material as could conveniently be displayed was held in the National Museum, continuing two evenings and two days.

The work of packing the collections for transmission to London was begun on the 27th of February. The first shipment of goods was made on the 7th of March, the last on the 14th of April. A satisfactory arrangement was made, through the agency of Col. Thomas Donaldson, (1) with the Pennsylvania Railroad Company, for the transmission of the collections to New York and placing them on board of the steamer, and (2) with Messrs. Patton, Vickers & Co., agents of the Monarch Line of steamships between New York and London, for reduced freights, the rates given covering the transmission of the collections to London and back to New York.

The party accompanying the collections consisted of Mr. Goode, who, in the inability of the Commissioner of Fisheries to attend, was appointed special commissioner, Dr. Tarleton H. Bean, Mr. R. Edward Earll, Capt. Joseph W. Collins, Mr. A. Howard Clark, Mr. William V. Cox, Mr. Reuben Wood, and Capt. H. C. Chester. All of these gentlemen were permanent members of long standing of the staff of the Fish Commission and National Museum, excepting Mr. Wood, who was selected to represent the angling interests, being one of the champion fly-casters of the United States, and an expert in all matters relating to fine tackle. In addition to those already named, Lieut. C. H. McLellan, U. S. Revenue Marine, was detailed by the Life-Saving Service; Mr. Max Hansmann from the Light-House Board; and Sergt. James Mitchell, U. S. A., from the Signal Office, to accompany and instal the collections sent over by their respective departments. Mr. R. I. Geare also accompanied the party as stenographer for work upon the report.*

The collections arrived in London in excellent condition. It was soon found that the space of 10,000 feet asked for by the United States was entirely inadequate for the purposes, being inconveniently arranged and badly cut up by partitions and passage-ways. Additional, but insufficient, space was subsequently obtained in various parts of the exhibition grounds, the most useful portion being a section of about 2,500 feet graciously conceded by the Danish commissioner, Mr. Howitz. The life-boats were placed in a shed erected by us in one of the gardens,

* On March 20, Messrs. Earll, Clark, Cox, and Chester sailed from Philadelphia; on March 31, Messrs. Goode, Collins, Hansmann, and Mitchell; on April —, Messrs. McLellan and Wood; on June 16, Mr. Geare; and on June 30, Dr. Bean. Mr. Wood arrived home August 7; Mr. Clark, August 25; Lieut. McLellan, August 29; Mr. Hansmann, September 16; Mr. Geare, September 18; Messrs. Goode and Collins, September 30; Sergt. Mitchell, November 22; and Messrs. Earll and Cox, January 10. Captain Chester returned finally January 16, having made a trip to the United States, for the summer work of the Fish Commission, from July 16 to October 14.

three of the fishing boats upon the lake, and the salted, smoked, and preserved fish in a special building put up for articles of this description, in an unfortunately remote portion of the grounds.

The exhibition was held in the grounds of the Royal Horticultural Society in South Kensington, nearly on the sites of the great London exhibitions of 1851 and 1862. It was the largest special exhibition ever held, being participated in by thirty-one nations and colonies. The area occupied was 21 acres, about one-third of the space being covered with temporary buildings, and the remainder devoted to lakes and gardens, which were decorated and arranged in the most attractive manner, and afforded a delightful breathing and resting place for visitors to the exhibition.

Although conducted by a corporation of private citizens, the exhibition was practically a Government enterprise, its patron being Her Majesty the Queen, and the president the Prince of Wales. It was formally opened and closed by the Prince of Wales, in the presence of the court and its most prominent officials and promoters, who were men in high official position. The surplus proceeds are to be devoted to some public enterprise, such as the improvement of the condition of the fishermen's widows and orphans or the establishment of a zoological marine laboratory for the benefit of the fisheries.

The buildings assigned to the United States being of a temporary nature, mere rough sheds of unplanned boards, whitewashed with some fire-proof preparation, it was necessary to prepare them by painting them in distemper, both for appearance sake and to prevent the disfigurement of the collections from the constant shower of flakes of whitewash. This occasioned some delay, but by dint of hard labor, night and day, our party succeeded in getting the section into presentable form in time for the formal opening, which took place on the 12th of May, having been deferred nearly two weeks on account of the illness of the Queen.

After the opening, several weeks were occupied in attaching labels and finally adjusting the collections, but by June 1 everything was in thorough order, and the section was generally admitted to possess the greatest interest and to be the most important single division of the entire exhibition, both on account of its contents and the manner in which they were displayed. The following paragraph from the Pall Mall Gazette is a sample of several hundred of a similar tenor which might be quoted :

"The United States section is a department whose importance grows upon the inquiring visitor at every inspection. With fisherman and angler alike it holds the supreme position in the entire exhibition. The section forms a very flattering manifestation of international courtesy upon the part of the Government at Washington, for by far the largest part of the exhibits are from the National Museum and from the storehouses of the U. S. Fish Commission—an institution for which

it would be rather difficult to find an English counterpart—the private exhibitors, particularly trading exhibitors, being very few. Of the comprehensiveness and completeness of this truly national exhibition it is impossible to speak too highly.”

Again, Major-General A. Pitt Rivers, a prominent ethnologist, in a letter to the editor of the Times, remarked as follows:

“In confirmation of the praise you justly bestow upon the arrangement of the United States department in the Fisheries Exhibition, I beg leave to draw attention to the fact that in the whole exhibition it is the only one which is arranged historically. In the Chinese, Japanese, Scandinavian, and Dutch courts, there are objects which the scientific student of the arts of life may pick out and arrange in their proper order in his own mind; but in that of the United States, * * * following the method adopted in the National Museum at Washington, [there has been] attempted something more to bring [the] department into harmony with modern ideas. * * * This gives the exhibition a value which is apart from commerce, and an interest which is beyond the mere requirements of fish-culture, and it may be regarded as one out of many indications of the way in which the enlightened Government of the United States marks its appreciation of the demands of science.”

Again, Mr. James Russell Lowell, minister to England, in a dispatch to the Secretary of State, under date of May 19, wrote:

“I have the honor to report that the International Fisheries Exhibition promises to be far more successful than even the most sanguine of its projectors had ventured to hope. The wisdom of Congress in making so liberal an appropriation in furtherance of its object is entirely justified both by the substantial encouragement given to the enterprise at its inception by this proof of interest on the part of the United States, and by the fact that the section devoted to our country is more valuable than that of any other, and valuable for reasons of which we may very properly be proud.

“I have the highest authority for saying that, quite apart from any consideration of intrinsic interest or curiosity, our share in the exhibition is superior to all others, in virtue of the scientific intelligence shown in its arrangement and classification, thus rendering it more instructive than any other. This is especially gratifying, because it is a triumph of a far higher kind than could be won by any ingenuity in our contrivances for the breeding or mechanical perfection in our implements for the taking of fish, though in these also we may safely challenge and in some cases defy comparison.

“The credit of this unquestioned success is due undoubtedly, in the first place, to Professor Baird, whose absence is universally regretted, but hardly less to the intelligence, zeal, and untiring energy of Professor Goode and his assistants, who worked literally night and day in order to be ready for the day fixed for the opening of the exhibition.

“I shall naturally have occasion to write again and more fully on this

topic when more perfectly informed, but could not deny myself the pleasure of reporting to you the impression already made in this international competition by the genius for organization of which our countrymen have here given proof, a faculty certainly not the lowest among those that distinguish the social and civilized man."

These paragraphs are reprinted here simply to give an idea of the appreciative enthusiasm with which the participation of the United States in the Fisheries Exhibition was received in England. It was generally understood that the action of Congress in making an appropriation for this purpose decided the fate of the enterprise, in so far at least as its international character was concerned, since many nations which had before been undecided as to their action were finally influenced on account of this evidence of international courtesy and comity.

The members of our party express themselves as having been extremely gratified by the courtesy and aid which they received at the hands of the managers of the exhibition, particularly Mr. Edward Birkbeck, chairman of the executive committee, to whom, indeed, the inception and the success of the exhibition is mainly to be attributed; Professor Huxley; Sir Philip Cunliffe-Owen; Mr. A. J. R. Trendell, literary superintendent; Surgeon-General Francis Day; Mr. Fell-Woods; Mr. W. Oldham Chambers; and Sir James Gibson Maitland. From the opening of the exhibition, on May 12th, to its close, October 30th, the buildings and grounds were thronged with visitors, not only in the day but at night, when the buildings and grounds were illuminated by electric lights. The exhibition was a favorite resort for the London people through the summer, and was rendered more attractive by two daily open-air concerts by military bands. The total number of visitors was 2,690,000, an average of 18,545 per day.

On the 18th of June began the international fishery conferences at the exhibition, the opening address being given by Professor Huxley, the Prince of Wales in the chair. These conferences continued for nearly three months, taking place every day except Wednesday and Saturday, and two papers usually being read at each session. The chair was always taken by some distinguished man, and the reading of each paper was followed by general discussion. The attendance varied from one hundred to five hundred, a considerable number of the attendants being official delegates sent by the various Governments participating in the exhibition, selected on account of their familiarity with fisheries and kindred topics. About fifty papers were read, many of them of great importance, and dealing with subjects never before taken up for discussion. June 25 was devoted to the fisheries of the United States, and a paper was read by Mr. Goode upon "The Fishery Industries of the United States and the Work of the U. S. Fish Commission," Mr. James Russell Lowell presiding. In seconding the vote of thanks, Professor Huxley, in the course of his remarks, said: "The great moral of the United States contribution to this exhibition * * * was that if this country, or any society which could be formed of sufficient extent to take up the

question, was going to deal seriously with the sea fisheries, and not to let them take care of themselves, as they had done for the last 1,000 years or so, they had a very considerable job before them; and unless they put into that organization of fisheries the energy, the ingenuity, the scientific knowledge, and the practical skill which characterized his friend, Professor Baird, and his assistants, their efforts were not likely to come to very much good. One of his great reasons for desiring that the subject which * * * had been put before them should be laid distinctly before the English public was to give them a notion of what was needed if the fisheries were to be dealt with satisfactorily, for he did not think, speaking with all respect to the efforts made by Sweden, North Germany, Holland, and so forth, that any nation at the present time comprehended the question of dealing with fish in so thorough, excellent, and scientific a spirit as the United States."

The conference papers, with the discussions, have all been printed, and, together with a series of illustrated popular hand-books, the reports of the juries, and the prize essays, will make up a very important contribution to the literature of fish and fisheries, making about twelve volumes octavo. The catalogue of the exhibition is in itself a small cyclopedia of fisheries, the account of the exhibit of each country being prefaced by a description of its fisheries by some expert. The establishment of a literary bureau, in charge of Mr. Trendell, under whose direction the publications were issued, was an important advance in exhibition administration.

The juries began their work early in June, and continued their activity about two months. A certain amount of jury work was done at a later period, even after the official announcement of the awards—a kind of jury work which seems exceedingly desirable that exhibitions should avoid in the future, if the dissatisfaction still being manifested in England is to be taken as a criterion. The United States was well represented on the juries by Messrs. Earll, Clark, Collins, McLellan, and Hansmann. Mr. E. T. Russell, of Boston, and Mr. Romyn Hitchcock, of New York, who were at that time in London, also served on juries, and Mr. Goode acted as one of the special jury upon prize essays.

The success of the participation of the United States was greatly increased by the fact that so many experts were employed upon its staff, and were constantly in attendance to explain and give significance to the collections—Captain Collins in everything relating to sea fisheries, vessels, and boats; Mr. Earll in fish-culture and the lake fisheries; Dr. Bean in marine zoology; Captain Chester in whaling and sealing; Mr. Clark in fishery products; Lieutenant McLellan in life-saving apparatus; Mr. Hansmann in light-house affairs; Mr. Wood in angling and fine tackle; and Sergeant Mitchell in the work of the Weather Bureau. No such attempt was made by any of the other countries, but its success was so manifest that it is hoped that it may serve as a precedent in future exhibitions.

The presence of these specialists was also important in connection with the work on the official report upon the exhibition and on the present state of the fisheries of Europe, which is now being prepared in accordance with the provision of the act of Congress directing our participation, and which I shall have the honor of submitting within a few months. This report, in addition to the narrative and descriptive part and a general review of European fishing, written by Mr. Goode, will contain special reports by Mr. Earll, upon European fish-culture and the herring and sardine fisheries; by Captain Collins, upon trawl-net fishing, the cod and mackerel fisheries of Europe, and upon fishing vessels and boats; by Mr. Clark, upon the European methods of preparing fishery products and upon the world's commerce in fishery products; by Mr. Cox, upon the English fish trade; by Mr. Hitchcock, upon the scientific apparatus; and by Lieutenant McLellan, upon life-saving appliances.

During the exhibition Mr. Earll visited the Scotch herring-fisheries and the fish-cultural establishment of Sir James Maitland at Stirling, and Captain Collins visited various fishing stations upon the south coast of England, having during a previous visit, at the close of the Berlin Exposition, made a trip upon a Grimsby trawling cutter and studied the trawl-net fishery from a practical standpoint. Mr. Goode's attention, in his leisure time, was, by my direction, devoted chiefly to studying methods of museum management in the great establishments of England; he also made a flying trip to Paris to study the museum methods there, having three years previously visited those of Germany and Italy. Dr. Bean visited the natural-history museums of Liverpool, London, Paris, Geneva, Vienna, and Berlin, to make certain comparisons required in connection with the fishery work.

An international anglers' tournament was held June 11th at Welsh Park, Hendon, under the direction of the Fishing Gazette. On this occasion Mr. Reuben Wood won two of the prizes, (1) for amateur fly-casting with single-handed fly rod, and (2) for amateur fly-casting with a salmon rod, the distance cast in the first instance being 72½ feet, in the latter 108 feet, the wind being considered an unfavorable one. On the 4th of July a trial of life-saving appliances took place in the Serpentine, Hyde Park, in which several American devices proved satisfactory.

The exhibition was formally closed October 30th by the Prince of Wales, and the work of packing the collections for shipment was at once taken up by Messrs. Earll, Chester, and Cox, the other members of the party having returned to their posts in Washington before the close of the exhibition; and before the end of the year the entire collection, in all between 500 and 600 tons, cubic measurement, had been returned to Washington, and the work of setting it up in the permanent fisheries gallery of the National Museum had been begun. Many important accessions to the collection were received during the exhibition, chiefly

by exchange, prominent among which were collective exhibits from Greece, Spain, India, Sweden, and China; an Irish curraick from the Marquis of Hamilton; illustrations of the net-maker's art, from Mr. W. B. Tegetmeier; a Danish vessel model, from Mr. Arthur Feddersen, of Viborg; &c. A considerable collection of fish-cultural appliances was given to the new National Fisheries Museum at South Kensington, in exchange for objects from India and China.

The prize list, as far as it can be tabulated from published official announcements up to April 1, 1884, stands as shown in the following table. Comment is unnecessary, except to remark that the United States has no reason to complain of its treatment at the hands of the juries, the acknowledgment of our participation in the substantial form of medallic awards being even greater than we had hoped for.

Eighteen gold medals and four silver ones were given to the Fish Commission, and one gold medal to the National Museum.

In addition to the medals and diplomas tabulated below there were received seven special money prizes, in value aggregating £65 sterling, or \$325, and seventeen diplomas of honor, given for "special services rendered" in connection with the exhibition.

No.	Name of country.	Gold.	Silver.	Bronze.	Diplomas.	Total.
1	United States.....	50	47	30	24	151
2	Norway.....	29	70	40	7	146
3	Sweden.....	27	36	40	19	122
4	Canada.....	17	15	6	4	42
5	New South Wales.....	11	9	4	1	25
6	Newfoundland.....	10	9	4	3	26
7	Spain.....	9	17	13	3	42
8	Netherlands.....	8	11	6	5	30
9	Russia.....	7	21	19	6	53
10	India.....	4	5	4	2	15
11	Italy.....	4	3	2	-----	9
12	France.....	3	6	8	3	20
13	Denmark.....	3	2	0	2	16
14	China.....	2	3	-----	1	6
15	Tasmania.....	1	4	-----	-----	5
16	Greece.....	1	3	-----	-----	4
17	Bahamas.....	1	1	1	1	4
18	Chili.....	-----	2	2	-----	4
19	Germany.....	-----	1	3	1	55
20	Belgium.....	-----	1	3	1	5
21	Jamaica.....	-----	1	2	5	8
22	Straits Settlements.....	-----	1	2	-----	3
23	Austro-Hungary.....	-----	1	-----	-----	1
24	Tunis.....	-----	1	-----	-----	1
25	Ceylon.....	-----	1	-----	-----	1
26	Japan.....	-----	-----	2	1	3
Total.....		184	271	200	89	747
England, Ireland, and Scotland*.....		155	253	212	128	748
Grand total.....		342	524	412	217	1,495

*Of the 155 gold medals awarded exhibitors of the United Kingdom, England received 110, Scotland 38, Ireland 7.

An International Exhibition of Agriculture and the Fisheries was held at Aalborg, Denmark, in June. In response to an invitation from the authorities, and with my approval, Mr. Goode sent over a number of objects which he had no room to display in London. The result was the award of a silver medal to the U. S. Fish Commission, and ten bronze medals to special exhibitors, chiefly of fishery products.

A detailed list of prize-winners both at London and Aalborg is given in the appendix to this report.

In closing the account of the fisheries exhibition it seems proper to mention by name the persons who contributed to its success, since in every instance their efforts were exerted far more strenuously than was required by their official duty. The following officers of the Musuem, some of whom were also on the staff of the exhibition, were directly engaged in selecting, labeling, and installing the collections: Mammals, Frederick W. True; aquatic birds, Robert Ridgway; aquatic reptiles and batrachians, Dr. H. C. Yarrow; fishes, Dr. Tarleton H. Bean; mollusks, Lieut. Francis Winslow, U. S. N.; aquatic invertebrates, fishing grounds, and scientific research, Richard Rathbun; apparatus and products of fishing, W. V. Cox and A. Howard Clark; boats and vessels, Capt. J. W. Collins; aboriginal fishing apparatus, J. King Goodrich; fish-culture, R. Edward Earll.

Mr. Henry W. Elliott, Mr. A. Z. Shindler, and Mr. Leopold Moeller, artists; Mr. T. W. Smillie, photographer; Messrs. Hornaday, Marshall, and Lucas, taxidermists; Messrs. Joseph and William Palmer and Mr. Hendley, modelers; Messrs. Hawley and Sweeney, preparators; and Mr. Curet, printer, also contributed largely to the success of the collection by their enthusiastic co-operation.

The co-operation of Messrs. Ferguson, McDonald, Atkins, Stone, and Clark in the preparation of the fish-cultural work was of great importance, as was also that of Messrs. Thomas Donaldson, E. G. Blackford, Barnet Phillips, W. A. Wilcox, A. R. Crittenden, James G. Swan, C. W. Smiley, and Henry Horan in various matters connected with the administration.

The important services of all those so briefly mentioned here will be described more fully in the special report on the exhibition; they are here referred to in order that formal acknowledgment may be made for their energetic and disinterested services in behalf of our display at the London Exhibition.

General E. H. Merritt and Col. L. G. Mitchell, consul-general and vice-consul of the United States in London, and Mr. W. J. Hoppin, secretary of legation, and Mr. William Wesley, should also be mentioned as having rendered important aid.

The official catalogue of the United States sections forms Bulletin 27 of the National Museum. It has been printed in parts, six of which were issued during the exhibition, viz:

	Pages.
A. Preliminary catalogue and synopsis	107
B. Collection of economic crustaceans, worms, echinoderms, and sponges, by Richard Rathbun	31
C. Aquatic and fish-eating birds, by Robert Ridgway	46
D. The whale fishery and its appliances, by J. T. Brown	116
E. Collection of fishes, by Tarleton H. Bean	124
F. Economic mollusca, apparatus and appliances used in their capture and preparation for market, by Lieut. Francis Winslow	81

Other parts will soon follow, viz :

- G. Apparatus of scientific research, by Richard Rathbun.
- H. Aquatic mammals, by Frederick W. True.
- I. Fish-culture and its appliances, by R. E. Earll.
- J. Fishing boats and vessels, by Joseph W. Collins.
- K. Apparatus of fishing, by A. Howard Clark.

9.—PUBLICATIONS IN 1883.

Reports.—The Report for 1880 (volume viii), two-thirds of which had been previously put in type, was completed early this year, the entire volume, with indexes and illustrations, being approved June 30. During the summer the press-work and binding were attended to, and the volume was ready for distribution October 31.

The Report for 1881 (volume ix) was pushed rapidly forward, and by the close of the year it was all in type except about 100 pages.

Bulletins.—Of the Bulletin for 1882, 160 pages had been printed and distributed in signatures in 1882. The remainder of the volume, consisting of 467 pages in all, was put in type and distributed in signatures between January and July. The edition ordered by Congress was then printed, and the bound volumes were ready for distribution August 27.

The volume for the current year was commenced immediately on the completion of the preceding volume (July 1st), and on December 31st the entire volume was in type. The signatures were distributed to about two hundred correspondents as fast as issued, the closing signatures, containing the index, having been mailed January 4th, 1884.

Pamphlets.—The number of copies of the Reports and Bulletins for distribution being comparatively limited, pamphlet editions of many of the papers were issued for general distribution. During the current year the following were issued :

GOODE, G. BROWN. Materials for a history of the swordfishes.

[From Report for 1880, pp. 287-392, pl. 24, index.]

GOODE, G. BROWN, JOSEPH W. COLLINS, R. E. EARLL, and A. HOWARD CLARK. Materials for a history of the mackerel fishery.

BAIRD, SPENCER F. Inducements offered fishermen to furnish shad eggs for the U. S. Commission of Fish and Fisheries.

[From Bulletin for 1882, pp. 389-391.]

BAIRD, SPENCER F. Preliminary catalogue and synopsis of the collections exhibited by the U. S. Fish Commission and by special exhibitors, with a concordance to the official classification of the exhibition.

[London Exhibition, part A, pp. 107.]

RATHBUN, RICHARD. Collection of economic crustaceans, worms, echinoderms, and sponges.

[London Exhibition, part B, pp. 31.]

RIDGWAY, ROBERT. Catalogue of the aquatic and fish-eating birds exhibited by the U. S. National Museum.

[London Exhibition, part C, pp. 46.]

WINSLOW, FRANCIS. Catalogue of the economic mollusca and the apparatus and appliances used in their capture and preparation for market. Exhibited by the U. S. National Museum.

[London Exhibition, part D, pp. 86.]

BROWN, JAMES TEMPLE. The whale fishery and its appliances.

[London Exhibition, part E, pp. 116.]

BEAN, TARLETON H. Catalogue of the collections of fishes exhibited by the U. S. National Museum.

[London Exhibition, part F, pp. 124.]

EARLL, R. EDWARD. The Spanish mackerel, *Cybium maculatum* (Mitch.) Ag.; its natural history and artificial propagation, with an account of the origin and development of the fishery.

[From Report for 1880, pp. 395-426.]

MCDONALD, MARSHALL. Specifications for the superstructure of the fishway proposed for the Great Falls, Potomac River, Maryland, pp. 3.

BAIRD, SPENCER F. Report of the Commissioner for 1880. A.—Inquiry into the decrease of food-fishes. B.—The propagation of food-fishes in the waters of the United States.

[From Report for 1880, pp. xvii-xlvi.]

POTTS, EDWARD. Freshwater sponges: what, where, when, and who wants them.

[From Bulletin for 1883, pp. 389-391.]

Carp publications.—During the year 1883 two editions of Hessel's pamphlet entitled "The carp and its culture in rivers and lakes" were issued for general distribution.

An additional pamphlet was prepared by Mr. Charles W. Smiley, entitled "Carp and Carp ponds," containing: (1) Answers to 118 questions relative to German carp; (2) directions concerning the construction of carp ponds. This pamphlet of 16 pages was the result of an effort to put into the form of questions and answers the principal facts which the correspondence of the Commission had shown that farmers and others desired to have in reference to carp. The directions for constructing ponds were accompanied by 7 large illustrative figures.

Later in the season a pamphlet of 32 pages by the same author was issued, entitled "Notes on the edible qualities of German carp and hints about cooking them." This was prepared from replies from several hundred circulars, which were sent to all parts of the country, addressed to persons who had received carp in 1879 or 1880. The testimonies of several hundreds of these were given verbatim, and the general

tenor of their statements was highly satisfactory, indeed fully up to the claims which the Commission had from time to time made concerning the carp as a food-fish. A few criticisms and uncomplimentary remarks were elicited by this correspondence, but in nearly every case there was internal evidence that the critics had undertaken to eat carp during the spawning season, had spoiled the fish in cooking, or that the fish had been kept in very foul water without efforts being made to purify the flesh thereafter.

These publications are forwarded to correspondents requesting them, and in reply to letters of inquiry, thus saving a large amount of letter-writing.

Mr. Charles W. Smiley, Chief of the Division of Records, during the year has had entire charge of the preparation of all matter for the printer, the correcting of the proofs of text and plates, and all else relating to the proper presentation of the several volumes, pamphlets, and circulars, as well as of their distribution to correspondents and applicants.

10.—THE WOOD'S HOLL STATION.

One of the most important directions in which the work of the Commission can be extended is in the multiplication, by artificial propagation, of the sea fishes, which constitute by far the most valuable element of the American fisheries in general. In this, we of course include the shell-fish and lobster. In the report for 1878 will be found a full account of the first experiments in this direction made by the Commission upon the cod at Gloucester, Mass. The results were very satisfactory as far as they went, and it was shown that all the various problems in the case could readily be solved with favoring circumstances. Several difficulties, however, existed at Gloucester; first, the absence of facilities for penning up the live fish until their eggs became ripe and ready for impregnation; second, the impurity of the sea-water, which caused a constant deposit of mud upon the eggs, destroying them in large part; third, the inclemency of the winter, involving the stoppage of the circulation of the water by freezing, and the killing of the fish if kept in floating cars at the surface; fourth, the inability to find, at reasonable cost, a suitable wharf or building in which the work could be prosecuted.

In spite of all these obstacles, however, a large number of codfish were hatched out and placed in Gloucester Harbor, without much expectation of hearing further from them. The fish used for the purpose were the gray variety, believed to come from the off-shore banks to the coast of the mainland for the purpose of spawning, the winter season being the period of this migration. During the following summer, however, small cod of the gray or off-shore variety were met with around the wharves in the harbor, and at once attracted attention, such an occurrence being quite unheard of before. Again, the next year, these fish were found outside of the harbor, and of considerably larger size,

fairly representing the second year of growth. The third year they were taken of a still larger size, and farther north along the coast, the fish of this school being universally known as "Fish Commission cod."

The codfish is, of course, taken freely on the Massachusetts coast during the summer season; but it is for the most part the rock or reddish cod, and not the gray or Banks cod, and is not of much commercial importance.

Subsequent to 1878 a careful search was prosecuted to find a location for the construction of a permanent hatching establishment for the marine fish; Noank, Stonington, Newport, Provincetown, and Wood's Holl passing successively in review. The last-mentioned place, however, was the only one that combined the necessary requirements to any reasonable degree.

The facilities heretofore furnished the Commission by the Light-House Board on its wharf (at Wood's Holl) were found entirely inadequate to the occasion, especially as the water of the Little Harbor was not satisfactory; a location was, however, found on a rocky point on the Great Harbor which it was believed would answer all the necessary purposes.

The river and harbor bill of the spring of 1882 included an appropriation for the construction of a harbor of refuge at Wood's Holl, and the Chief Engineer of the Army sanctioned some special adaptations of the plan of construction to meet the wants of the Fish Commission.

The projecting point in question, which it was desired to utilize as a station, formed part of a plot of ground belonging to Messrs. Isaiah Spindel & Co., of Wood's Holl, who offered it at the sum of \$7,250. For various reasons it was thought best to raise this amount by private subscription, the money to be paid and the land presented to the United States in the event of the actual construction by the Government of the pier and breakwater referred to. The money was accordingly furnished by the following parties:

Old Colony Railroad Company	\$2,500
John M. Forbes.....	1,000
Alexander Agassiz	500
Johns Hopkins University.....	1,000
Princeton College.....	1,000
Williams College	500
Isaiah Spindel & Co.....	500
Mrs. Robert L. Stuart	250

The colleges in question and Mr. Agassiz made their contribution with the understanding that, as far as possible, they were each to be allowed to send one specialist to the station for the purpose of carrying on scientific research.

In addition to these contributions, Mr. Joseph S. Fay, of Wood's Holl, presented to the United States a very valuable shore line, extending from the lot of Isaiah Spindel & Co., just referred to, to the grounds of the Pacific Guano Company; thus assuring a long stretch of shore where no buildings likely to be detrimental to the business of the Commission could be erected.

By direction of the Attorney-General of the United States, Hon. George P. Sanger, United States district attorney for Massachusetts, carefully investigated the titles of Messrs. Fay and Isaiah Spindel & Co., and pronounced them to be valid.

The property was then conveyed to two trustees, C. F. Choate, president of the Old Colony Railroad Company, and Mr. J. Malcolm Forbes, with the understanding, as stated, that whenever the work on the pier was formally begun the shore line should be transferred to the United States for the purposes of the U. S. Fish Commission, the value of the ground thus acquired being not less than \$15,000. The transfer being made, the whole transaction was submitted again to the Attorney-General and received his sanction.

In the mean time, an appropriation of \$25,000 had been made by Congress to commence the construction of the necessary buildings, and the plans of Mr. Robert H. Slack, of Boston, being selected, a contract was made with Mr. W. R. Penniman, of South Braintree, Mass., for the erection of the first building. Ground was broken in August, 1883, and by the end of the year the building was under roof.

Concurrently with the work on the foundations of the quarters building, the dredging of the trenches for building the piers of the engineer work was carried on, although, owing to the inefficiency of the dredge, not much work was accomplished during the year.

The series of buildings desired for the Commission was as follows:

1. A building available for offices, and for storage of boats and other property, and for hatching purposes; also for quarters for the persons occupied at the establishment during the several seasons of the year; this to include the necessary accommodations for the mess.*

As there was no assurance that another appropriation would be made by which to complete the series, this building was arranged to supply all requirements on a limited scale, and the expenditure of the appropriation was limited to this building and the next.

2. A reservoir with suitable pumping facilities, in which could be stored salt and fresh water, and from which it could be distributed to different parts of the establishment.

3. A fish-hatching building, where the work of fish propagation could be conducted, and which should also furnish facilities for the collateral operations authorized by Congress.

4. A coal shed, where a supply of coal for the steamers of the commission could be kept.

5. A storehouse for keeping supplies.

It was expected to utilize the pier and breakwater to be constructed

* Heretofore, in order to meet the needs of the party working at the summer station, a mess had been organized which was furnished accommodations in one of the hired buildings. This was a self-supporting affair, managed by a caterer who paid all expenses for provisions and service from the mess fund, which was kept up by the payment of \$1 per day by each member.

by the engineer department, by establishing it as a marine station for the accommodation of the Albatross, Fish Hawk, Lookout, &c., and for basins in which to keep the fish, lobsters, &c., undergoing treatment.

The building for the quarters was the first to be constructed, in view of the impossibility of obtaining the necessary accommodations in the village of Wood's Holl. The place is without any hotel, and has but a single boarding-house, which is generally filled in the summer season by regular boarders. During 1881, 1882, and also 1883, the Commission was obliged to scatter all over the village, renting three buildings for offices and other purposes, and obtaining single rooms wherever they could be had. It was considered of the utmost importance in the interest of economy and of efficiency to concentrate all this force, so that the business of the Commission could be properly transacted; and it is hoped that the report for 1884 will chronicle the completion of this work, and the successful commencement of the fish-hatching and other operations.

The work at the station for the year was quite similar to that of 1882, except that by means of the Albatross a much wider range of research was prosecuted, as will be seen in the special paragraph on that vessel.

As usual, a large number of scientific specialists, partly connected with the Commission and partly volunteers from the colleges of the country, were present; and great additions were made to our knowledge of the animal forms of the sea, and their mutual relationships and dependencies. As heretofore, collections in great magnitude were obtained, and taken to Washington at the close of the season, the duplicates, after supplying the National Museum, to be made up in sets for distribution, on the indorsement of members of Congress, to the various colleges and academies throughout the country.

This subsidiary work of the Commission has proved to be very acceptable to all persons interested, bringing to educational institutions in the far West the same facilities for instruction in marine natural history as were previously possessed only by those situated near the seaboard.

I refer to the report of the Commissioner for the year 1882 for further and minuter details in regard to the early history of the project for a permanent station, and the steps leading to its realization.

11.—VISITS FROM FOREIGN SPECIALISTS.

On the 5th of March Capt. G. M. Dannevig, of Arendal, Norway, visited Washington for the special purpose of ascertaining the methods adopted by the U. S. Fish Commission in hatching cod, with a view to introducing them into his country where (particularly on the southern coast) cod and other fishes appear to be rapidly diminishing. Every facility was given him for studying the subject, and after his return to Norway he made a quite successful experiment. He used the

Clark hatching-box in preference to other apparatus brought to his attention.

Mr. Henry Grosjean was sent by the French department of agriculture to study up several subjects. He paid particular attention to the work of the Fish Commission, and on his return to France prepared an elaborate report to the minister.

12.—PROVISION FOR THE EVENT OF DISABILITY OF THE COMMISSIONER.

In view of there being no provision of law by which the functions of the Commissioner of Fish and Fisheries could be exercised, in case of his absence or disability, an act was passed by Congress, and approved March 3, 1883, to remedy this defect.

In pursuance of this authority Mr. T. B. Ferguson was designated as Assistant Commissioner on the 7th of July, and a letter was transmitted to the Secretary of the Treasury notifying him of the fact.

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

13.—THE INVESTIGATION OF THE MENHADEN FISHERY BY THE SENATE COMMITTEE.

The appointment of a subcommittee of the Senate to investigate the subject of the menhaden fishery was chronicled in the report of 1882, and a résumé given therein of what was accomplished, leaving the work to be continued in 1883.

The investigation was appointed to begin between the 20th of June and the 4th of July, with sessions at Atlantic City, Asbury Park, Long Branch, and Brighton Beach, and the Commissioner was invited to accompany the committee either personally or by proxy.

Mr. Marshall McDonald was accordingly designated to represent the Fish Commission, and on July 11 wrote from Cape May that the investigation had commenced, the three Senators being present. Senator Sewell and several representative men of New Jersey were also there to testify. The committee had asked for the use of the Fish Hawk, but as she was engaged in Spanish mackerel and oyster work it was not found possible to divert her from that duty. Later the committee proceeded to Portland, Me., where the last session was held July 25. On the way to Portland several sessions were held in Boston. On the 4th of October Senator Lapham applied for the steamer Lookout, with which to reopen the investigation in the Chesapeake. He was accordingly met by Mr. McDonald at Fortress Monroe October 12, where they established their headquarters, and, with the aid of the Lookout, visited the menhaden factory of Darby & Smithers at Back River, and other points. The testimony taken by the committee has been published by order of the Senate.

14.—THE FISHERY CENSUS OF 1880 AND ITS RESULTS.

As stated in preceding reports, an arrangement was made with General Francis A. Walker, Superintendent of the Tenth Census, in 1879, by which an investigation of the fisheries of the United States was undertaken as the joint enterprise of the U. S. Fish Commission and of the Census Bureau. It was decided that this investigation should be as exhaustive as possible, and that both the U. S. Fish Commission and the Census should participate in its preparation. The making up of a statistical and historical account of the fisheries, in general, to be published in the report of the Superintendent of the Census, was from the first the main object, but in connection with this, exhaustive investigations into the methods of the fisheries, the location and extent of the fishing grounds, and the natural history of useful marine animals were carried on.

The details of the proposed research were drawn up before the beginning of the work, and were published in an octavo pamphlet of fifty-four pages, entitled "Plan of Inquiry into the History and Present Condition of the Fisheries of the United States. Washington, Government Printing Office, 1879," and was reproduced in the 1880 Report, Part VIII, pp. 3-52.

The expense of the field-work from July 1, 1881, was for the most part borne by the Census, together with a large amount of compilation work carried on by clerks detailed from the Census Office in Washington. That involved in the preparation of the report, final tabulation of statistics of production, and preparation of illustrations has been mainly at the cost of the Fish Commission. Since February, 1881, Mr. Goode's connection with the Census Office has been purely nominal, and his services in the preparation of the reports and in connection with their publication have been rendered without compensation, in addition to his regular duties as assistant director of the National Museum. In the same manner a large share of the most important work upon special parts of the report has been the volunteer labor of officers of the National Museum and Fish Commission, in addition to their regular duties. A number of employees of the Fish Commission were detailed from time to time for special work upon this report, for periods varying from four months to two years.

The participation of the Census Office and the Commission of Fish and Fisheries has involved the expenditure of probably nearly equal amounts of money, and the division of the results, so far as they are represented in reports ready for the printer, has been arranged to the satisfaction of both. The extent of the material collected has, however, been much greater than was anticipated, and the portion assigned to the Fish Commission being too bulky for publication in the annual reports, application was made to Congress for permission to print as a separate special report an illustrated work in quarto upon the Food-Fishes and Fisheries of the United States.

This permission was granted in a joint resolution, which passed the Senate July 16, 1882.*

The manuscript of the entire report is for the most part ready for the printer, and several hundred drawings for the illustrations are finished. Part I was placed in the hands of the printer in August, 1882, and would have been published during the present year but for the absence of Mr. Goode in England in the performance of other duties in connection with the Commission. The contents of these reports will approximately be as follows, though it is probable that other topics may be added to the discussion before the work is completed :

THE FOOD-FISHES AND FISHERY INDUSTRIES OF THE UNITED STATES.

- PART**
- I.—The Natural History of Useful Aquatic Animals.
 - II.—The Fishing-Grounds.
 - III.—The Fishing Towns, containing a geographical review of the Coast, River, and Lake Fisheries.
 - IV.—The Fishermen.
 - V.—The Apparatus of the Fisheries and Fishing Vessels and Boats.
 - VI.—The Fishery Industries, a discussion of methods and history.
 - VII.—The Preparation of Fishery Products.
 - VIII.—Fish-Culture and Fishery Legislation.
 - IX.—Statistics of Production, Exportation, and Importation. Summary Tables.
 - X.—The Whale Fishery; a special monograph.
 - XI.—A Catalogue of the Useful and Injurious Aquatic Animals and Plants of North America.
 - XII.—A List of Books and Papers relating to the Fisheries of the United States.
 - XIII.—A General Review of the Fisheries, with a statistical summary.

The report prepared for the Superintendent of the Census, the manuscript of which is now for the most part in his possession, is divided into the following sections :

A REPORT UPON THE STATISTICS OF THE FISHERIES AND FISH TRADE OF THE UNITED STATES.

Introduction (giving a comprehensive abstract of the matter contained in the quarto report referred to above).

- PART I.**—A Review of the Fisheries of the Atlantic Seaboard, with statistics of production and manufactures.
- II.—A Review of the Fisheries of the Pacific Coast, with statistics of production and manufactures.
 - III.—A Review of the Fisheries of the Great Lakes, with statistics of production and manufactures.
 - IV.—A Review of the River Fisheries of the United States. (Prepared by C. W. Smiley.)
 - V.—A Review of the Consumption of Fish by Counties, with an estimate of the extent and value of the inland fisheries. (Prepared by C. W. Smiley.)

* For text of bill, see Report U. S. F. C., 1882, Part X, p. xlvii.

PART VI.—A Review of the Fish Trade of cities of the United States having a population of more than 10,000 in 1880. (Prepared by C. W. Smiley.)

VII.—Statistics of Importation and Exportation of Fishery Products from 1730 to 1880.

VIII.—List of the Fishing Vessels of the United States in 1880, giving tonnage, value, number of crew, name of owner, branches of fisheries engaged in, together with other important details.

IX.—Monograph of the Seal Islands of Alaska. By Henry W. Elliott. (Already in type; 171 pages. 4to.)

X.—Monograph of the Oyster Fisheries. By Ernest Ingersoll. (Already in type; 251 pages.)

This series includes all compilations from circulars, and the results of the work performed by clerks detailed from the Census Office, together with much derived from the archives of the Fish Commission.

The first three sections are mainly made up from the material collected by the special agents in the field, and the form is as nearly as possible that in which it was originally collected; much, however, has been added from the archives of the Commission.

By the plan just detailed the statistical matter gathered by the joint efforts of the two organizations is assigned to the Census, together with a sufficient amount of descriptive and explanatory text to make the statistics fully intelligible, while the descriptive, historical, and natural history papers are taken by the Fish Commission, these being enriched by a sufficient amount of statistical detail to render them as useful as possible for the class of readers and students for whom they are intended.

The statistical results of the investigations have already been published in a preliminary way. A series of special statistical tables appeared in the bulletins of the Census Office, as follows:

- (1) Census Bulletin No. 176.—[Preliminary report upon the Pacific States and Territories] prepared by Mr. Goode from returns of Special Agents Jordan, Swan, and Bean. Dated May 24, 1884. 4to. pp. 6 (+2).
- (2) Census Bulletin No. 261.—Statistics of the Fisheries of the Great Lakes. Prepared by Mr. Frederick W. True from notes of Special Agent Kumlien. Dated September 1, 1881. 4to. pp. 8.
- (3) Census Bulletin No. 278.—Statistics of the Fisheries of Maine. Prepared by Mr. R. E. Earll from his notes and those of Mr. C. G. Atkins. Dated November 22, 1881. 4to. pp. 47 (+1).
- (4) Census Bulletin No. 281.—Statistics of the Fisheries of Virginia. Prepared by Col. Marshall McDonald. Dated December 1, 1881. 4to. pp. 8.
- (5) Census Bulletin No. 291.—Statistics of the Fisheries of New Hampshire, Rhode Island, and Connecticut. Prepared by Mr. A. Howard Clark. Dated April 5, 1882. 4to. pp. 7 (+1).
- (6) Census Bulletin No. 295.—Statistics of the Fisheries of Massachusetts. Prepared by Mr. A. Howard Clark from returns of Special Agents Wilcox, Clark, True, Collins, and Atwood. Dated March 1, 1882. 4to. pp. 35 (+1).
- (7) Census Bulletin No. 297.—Commercial Fisheries of the Middle States. Prepared by Mr. R. E. Earll and Col. M. McDonald. Dated June 5, 1882. 4to. pp. 14. (This bulletin includes statistics of No. 4. C. B. No. 281.)

- (8) Census Bulletin No. 298.—Commercial Fisheries of the Southern Atlantic States. Prepared by Mr. R. E. Earll and Col. M. McDonald. Dated June 5, 1882. 4to. pp. 18.

In all 148 pages, quarto.

In addition to these, certain special tables have appeared :

- (9) Statistical Table.—Statistics of the Fisheries of the United States in 1880. [Prepared by Messrs. Goode and Earll from the reports of special agents.] Printed in Compendium of the Tenth Census, p. 88. pp. —. Republished in Bulletin of the U. S. Fish Commission, vol. iii, 1883, pp. 270–271, and in Preliminary Catalogue, International Fisheries Exhibition, January, 1883, p. 5.
- (10) Statistical Table.—Table showing by States the quantity of Spanish mackerel taken in 1880, and the total catch for the United States. By R. Edward Earll. Report U. S. Fish Commission. Part VIII, 1880, p. 416.
- (11) Statistical Summary.—Statistics of the Davis Strait Halibut Fisheries. By Newton P. Scudder. Report U. S. Fish Commission. Part VIII, pp. 190–192.
- (12) Statistical Summary.—Statistics of the Swordfish Fishery. By G. Brown Goode. Report U. S. Fish Commission. Part VIII, pp. 361–367.
- (13) Statistical Summaries.—Statistics of the Mackerel Fishery in 1880. By R. Edward Earll. Report U. S. Fish Commission. Part IX, pp. [124]–[127].
[Statistics of the Mackerel Canning Industry.] By R. Edward Earll. Ibid, p. [131].
Statistics of the inspection of mackerel from 1804 to 1880. By A. Howard Clark. Ibid, pp. [162]–[213].
Vessels in the Mackerel Fishery in 1880. Ibid, p. [418].
Catch of mackerel by Americans in Canadian waters, 1873–'81. Ibid, p. [430].
- (14) Introduction to Section B., U. S. Catalogue International Fishery Exhibition, London. (Collection of Economic Crustaceans, Worms, Echinoderms, and Sponges.) By Richard Rathbun. pp. [3]–[20]. Crabs, p. [3]; Lobsters, p. [6]; Crayfish, p. [10]; Shrimps and Prawns, p. [11]; Sponges, p. [18]; &c.
- (15) Introduction to Section D., U. S. Catalogue International Fishery Exhibition. (Catalogue of the Economic Mollusca and the apparatus and appliances used in their capture and preparation for market, exhibited by the U. S. National Museum.) By Lieut. Francis Winslow, U. S. N. pp. [3] to [58]. Aggregate table of production, p. [3]; special tables and statistical tables throughout.
- (16) Introduction to Section E., U. S. Catalogue International Fishery Exhibition. (The whale fishery and its appliances). By James Temple Brown. pp. [3]–[25].
- (17) Statistics of the Whale Fishery. By A. Howard Clark, in the preceding, pp. [26]–[29].
- (18) A review of the fishery industries of the United States, &c. By G. Brown Goode. An address at a conference of the International Fishery Exhibition, June 25, 1883. 8vo., pp. 84. Numerous statistical statements, summaries, and tables.
- (19) Administrative Report.—Method and results of an effort to collect statistics or the fish trade and consumption of fish throughout the United States. By Charles W. Smiley. Bulletin U. S. Fish Commission, vol. ii, 1882, pp. 247–252.

Two special reports have also been published as follows :

- (20) A monograph of the Seal Islands of Alaska. By Henry W. Elliot. 4to., illustrated. pp. 172. An edition of this report with substitutions on pp. 102-109 was also issued as a special bulletin of the Fish Commission, No. 176.
- (21) The Oyster Industry. By Ernest Ingersoll. 4to., illustrated. pp. 252.

Part I of the special report on the Food-Fishes and Fishery Industries of the United States, ordered by Congress July 16, 1882, has been put in type, as has been stated, and at the end of the year was awaiting the completion of the engraved plates. This volume, devoted to the natural history of the useful aquatic animals, contains 895 pages quarto. The character of its contents may best be indicated by the following analysis :

PART I.—MAMMALS.

- A. Whales and porpoises. By G. Brown Goode
- B. Seals and walruses. By Joel A. Allen.
- C. Habits of the fur-seal. By Henry W. Elliot.
- D. Manatees and the arctic sea-cow. By Frederick W. True.

PART II.—REPTILES AND BATRACHIANS. By Frederick W. True.

- E. The alligator and crocodile.
- F. Tortoises, turtles, and terrapins.
- G. The amphibians.

PART III.—FISHES. By G. Brown Goode. With discussions of species, by David S. Jordan and Tarleton H. Bean, notes on the fishes of the Gulf of Mexico by Silas Stearns, and contributions from Joseph W. Collins, N. E. Atwood, Marshall McDonald, R. Edward Earll, Ludwig Kumlien, and other authorities.

- H. The file-fishes, pipe-fishes, and anglers.
 - 1. Flat-fishes and flounders.
- J. The cod family and its kindred.
- K. Wolf-fishes, sculpins, and wrasses.
- L. Mackerel and its allies.
- M. The tilefish family and others.
- N. The drum family.
- O. The sheepshead, bass, bream, perch, &c.
- P. Barracuda, mullet, pike, and mummachog.
- Q. The salmon tribe.
- R. The herring and the menhaden.
- S. The shad and the alewives.
- T. Families related to the Clupeidæ.
- U. Carp, suckers, catfish, and eels.
- V. Sturgeons, skates, sharks, and lampreys.

PART IV.—MOLLUSKS.

- W. Mollusks in general. By Ernest Ingersoll.
- X. The life history of the oyster. By John A. Ryder.

PART V.—CRUSTACEANS, WORMS, RADIATES, AND SPONGES. By Richard Rathbun.

- Y. Crustaceans.
- Z. Worms.
- Za. The radiates.
- Zb. The poriferans.

This constitutes the first volume of this series and will be illustrated by 432 engravings of aquatic animals, arranged upon 277 plates.

Part II of the same work, consisting of a treatise upon the fishing grounds of North America, by Richard Rathbun and Capt. Joseph W. Collins, has been sent to the printer.

Nothing has been printed by the Census Office excepting a summary table of the fisheries in the Compendium published during the present year, which is here reproduced:

Statistics of the fisheries of the United States in 1880.

States and Territories.	Grand total.			Persons employed.		Apparatus and capital.		
	Persons employed.	Capital invested.	Value of products.	Fishermen.	Shoremen.	Vessels.		
						Number.	Tonnage.	Value.
The United States	No.	Dollars.	Dollars.	No.	No.			Dollars.
	131,426	37,953,349	43,046,053	101,684	29,742	6,605	208,297.82	9,357,282
New England States.....	37,043	19,937,607	14,270,393	29,838	7,205	2,066	113,602.59	4,562,131
Middle States, exclusive of Great Lake fisheries	14,981	4,426,078	8,676,579	12,584	2,397	1,210	23,566.93	1,382,000
Southern Atlantic States.....	52,418	8,951,722	9,602,737	38,774	13,644	3,014	60,886.15	2,375,450
Gulf States.....	5,131	545,584	1,227,544	4,382	749	197	3,009.86	308,051
Pacific States and Territories..	16,803	2,748,383	7,484,750	11,613	5,190	56	5,463.42	546,450
Great Lakes.....	5,050	1,345,975	1,784,050	4,493	557	62	1,768.87	183,200
1 Alabama	635	38,200	119,275	545	90	24	317.20	14,585
2 Alaska	6,130	447,000	2,661,640	6,000	130	.....	.....	.....
3 California	3,094	1,139,675	1,860,714	2,089	1,005	49	5,246.80	535,350
4 Connecticut	3,131	1,421,020	1,456,866	2,585	546	291	9,215.95	514,050
5 Delaware	1,979	268,231	997,695	1,662	317	69	1,226.00	51,600
6 Florida	2,480	406,117	643,227	2,284	196	124	2,152.97	272,645
7 Georgia	899	78,770	119,993	809	90	1	12.00	450
8 Illinois	300	83,400	60,100	265	35	3	209.73	8,500
9 Indiana	52	29,360	32,740	45	7	1	21.90	2,500
10 Louisiana.....	1,597	93,621	392,610	1,300	297	49	539.69	20,821
11 Maine	11,071	3,375,994	3,614,178	8,110	2,961	606	17,632.65	633,542
12 Maryland.....	26,008	6,342,443	5,221,715	15,873	10,135	1,450	43,500.00	1,750,000
13 Massachusetts.....	20,117	14,334,450	8,141,750	17,165	2,952	1,054	83,232.17	3,171,189
14 Michigan	1,781	442,665	716,170	1,600	181	36	914.42	98,500
15 Minnesota	35	10,160	5,200	30	5	1	33.59	5,000
16 Mississippi	186	8,800	22,540	110	76	.....	.....	.....
17 New Hampshire.....	414	209,465	176,684	376	38	23	1,019.05	51,500
18 New Jersey	6,220	1,492,202	3,176,589	5,659	561	590	10,445.00	545,900
19 New York	7,266	2,629,585	4,380,565	5,650	1,616	541	11,582.51	777,600
20 North Carolina.....	5,274	506,561	845,695	4,729	545	95	1,457.90	39,000
21 Ohio	1,046	473,800	518,420	925	121	9	359.51	38,400
22 Oregon	6,835	1,131,350	2,781,024	2,795	4,040	.....	.....	.....
23 Pennsylvania.....	552	119,810	320,050	511	41	11	321.99	10,500
24 Rhode Island.....	2,310	596,678	880,915	1,602	708	92	2,502.77	191,850
25 South Carolina.....	1,005	66,275	212,482	964	41	22	337.32	15,000
26 Texas	601	42,400	128,300	491	110	.....	.....	.....
27 Virginia	18,864	1,914,119	3,124,444	16,051	2,813	1,446	15,578.93	571,000
28 Washington	744	30,358	181,372	729	15	7	216.62	11,100
29 Wisconsin.....	800	222,840	253,100	780	70	11	220.25	26,700

Statistics of the fisheries of the United States in 1880.

Apparatus and capital—cont'd.				Value of products by fisheries.						
Boats.		Value of minor apparatus and outfit.	Other capital, including shore property.	General fisheries.	Whale fishery.	Seal fishery.	Menhaden fishery.	Oyster fishery.	Sponge fishery.	Marine salt industry.
Number.	Value.									
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
44,804	3,465,393	8,145,261	17,987,413	22,405,018	2,323,943	2,289,813	2,116,787	13,403,852	200,750	305,890
14,787	739,970	5,038,171	9,597,335	10,014,645	2,121,385	111,851	533,722	1,478,900	.....	3,890
8,293	546,647	674,951	1,822,480	2,882,294	.....	.....	1,261,385	4,532,900	.....	.....
13,331	640,508	1,145,878	4,789,886	2,217,797	408	.....	315,680	7,068,852	.....	.....
1,252	50,173	52,823	134,537	713,594	.....	.....	.....	313,200	200,750	.....
5,547	404,695	467,238	1,350,000	4,792,638	202,150	2,177,962	.....	10,000	.....	302,000
1,594	83,400	766,200	313,175	1,784,050	.....	.....	.....	.....	.....	.....
119	10,215	7,000	6,400	74,325	.....	.....	.....	44,950	.....	1
3,000	60,000	7,000	380,000	564,640	500	2,096,500	.....	.....	.....	2
853	91,485	205,840	307,000	1,341,314	201,650	15,750	.....	.....	.....	3
1,173	73,585	375,535	457,850	383,887	32,048	111,851	256,205	672,875	.....	302,000
839	33,227	70,324	113,080	309,029	.....	.....	941	687,725	.....	4
1,058	28,508	39,927	65,037	426,527	.....	.....	.....	15,950	200,750	5
358	15,245	18,445	44,450	84,993	.....	.....	.....	35,000	.....	6
101	2,000	11,900	61,000	60,100	.....	.....	.....	.....	.....	7
15	1,650	20,210	5,000	32,740	.....	.....	.....	.....	.....	8
165	4,800	18,000	50,000	192,610	.....	.....	.....	200,000	.....	9
5,920	245,624	934,593	1,562,235	3,576,678	.....	.....	.....	37,500	.....	10
2,825	186,448	297,145	4,108,850	479,388	.....	.....	11,851	4,730,476	.....	11
6,749	351,736	3,528,925	7,282,600	5,581,204	2,089,337	.....	61,769	405,550	.....	12
454	10,345	272,920	60,900	716,170	.....	.....	.....	.....	.....	13
10	900	3,760	500	5,200	.....	.....	.....	.....	.....	14
58	4,600	1,600	2,609	12,540	.....	.....	.....	10,000	.....	15
211	7,780	60,385	89,800	170,834	.....	.....	.....	6,050	.....	16
4,065	223,963	232,339	490,000	949,678	.....	.....	146,286	2,080,625	.....	17
3,441	289,885	390,200	1,171,900	1,689,357	.....	.....	1,114,158	1,577,050	.....	18
2,714	123,175	225,436	118,950	785,287	408	.....	.....	60,000	.....	19
487	29,830	253,795	151,775	518,420	.....	.....	.....	.....	.....	20
1,360	246,600	245,750	639,000	2,776,724	.....	4,300	.....	.....	.....	21
156	13,272	40,538	55,500	132,550	.....	.....	.....	187,500	.....	22
734	61,245	138,733	204,850	302,242	.....	.....	221,748	356,925	.....	23
501	9,790	25,985	15,500	192,482	.....	.....	.....	20,000	.....	24
167	15,000	4,400	23,000	81,000	.....	.....	.....	47,300	.....	25
6,618	292,720	560,763	489,636	602,239	.....	.....	303,829	2,218,376	.....	26
334	6,610	8,648	4,000	109,960	.....	61,412	.....	19,000	.....	27
319	24,975	145,165	26,000	253,100	.....	.....	.....	.....	.....	28
										29

An additional amount of completed manuscript of considerable magnitude has been delivered during the year to the Superintendent of the Census, for publication in the Census Report upon the statistics of the fisheries and fish trade of the United States, consisting of Parts V and VI of this report, as indicated in the analysis printed above.

15.—SUPPOSED DESTRUCTION OF THE TILEFISH.

Reference has been made in a preceding report to the phenomena connected with a wholesale destruction of the tilefish (*Lopholatilus chamaeleonticeps*), an important food-fish recently brought to notice by the U. S. Fish Commission as occurring off the coast. The futile efforts to find even a few survivors were recorded in the report for 1882. A new attempt was made in 1883 by the Albatross, which proceeded to the ground and devoted several days to using a well-baited trawl and hand-line. She failed to meet with success, however, and for the present, at least, we must give up any expectation of renewing our acquaintance with the species. The search developed the remarkable fact that the associates of the tilefish, which were formerly found in great abundance at the same place, have either disappeared entirely or are represented by only an insignificant remnant. There is no theory that accounts for these phenomena satisfactorily, although it is suggested that it may have been due to an incursion of cold water from the arctic region or of warm water from the Gulf Stream. It is not unreasonable to presume that either of these conditions would produce an effect on fishes living in an intermediate temperature.

16.—THE POLE-FLOUNDER.

The pole-flounder, which was one of the most important discoveries made by the Commission in the earlier years of its work, continues to be met with over a wide range, occurring in a greater and greater depth as one proceeds southward. It is taken in almost every haul of the dredge, down to several hundreds of fathoms. As an article of food it is at least equal, if not superior, to any species of that family in the United States. The anomaly of its being so abundant, and yet never being taken except by the U. S. Fish Commission, is explained by the fact that it can be caught only by means of the trawl-net, the mouth of the fish being so small and weak as to prevent its swallowing a hook large enough to sustain its weight when hauled up. Connoisseurs in New York, to whom specimens were sent, pronounced it to be one of the best of American fishes, and in every respect equal to the far-famed sole.

17.—THE BLACK COD OF THE PACIFIC.

Among the fisheries of the United States of much promise in the future, but not yet developed, is that of the black cod (*Anoplopoma fimbria*), a species not in any way related to the true cod. It occurs along

the entire coast of California, Oregon, and Washington Territory, its extreme northern range not being determined. It is not much esteemed in its southern area of distribution, but in Washington Territory it is very highly prized, being much sought by the Indians. It lives in deep water, and can be caught on trawl-lines like the cod and halibut. We owe to Mr. James G. Swan, of Port Townsend, Wash., the first suggestion of the commercial and economical value of this fish for food purposes, and he informs us that the fish is eaten both fresh and salted. Several hundredweights of the salted fish were sent to the Commission by Mr. Swan, and these were treated, at the suggestion of Mr. Wilcox, by smoking, after which they were distributed to experts, who pronounced the fish to be one of the best known to them. Especial interest was excited among the fish dealers of Gloucester, Boston, and New York, and several expressed the intention of sending some one to Washington Territory for the purpose of effecting large catches of the fish for regular market treatment.

18.—NEW MODEL OF FISHING VESSEL.

As stated elsewhere, Captain Collins, a member of the Commission, is at present engaged in preparing the model of a fishing schooner to combine the best points of the American and British vessels, and made after studying the peculiar characters of both. It is proposed to ask from Congress the means to build after this model, and should it be generally followed, we may hope to witness a notable decrease in the loss of life and property. In 1883 Gloucester had a fleet approximating 400 fishing vessels, carrying from 4,300 to 4,800 men. About one-half to three-fourths of this fleet has been engaged in some branch of the winter fisheries, the rest of the vessels being hauled up about five months in the year.

In the ten years from 1874 to 1883 the total loss of vessels was 147, of which number 82 foundered at sea, 7 of the latter having been abandoned in a sinking condition. The total value of these vessels was \$735,126. The total loss of life was 1,233 men, 895 of whom went down in their vessels, which foundered at sea. It is a little difficult to get at the exact number of bereaved families that lost their natural protectors, since for one or two years of the period under consideration accurate record was not kept of the widows and fatherless children left by these disasters at sea, and even if it had been it would not show how many almost helpless parents were deprived of their only means of support. As near as a correct estimate can be obtained, and this is probably an underestimate, 322 women were made widows and 658 children left fatherless by the disasters to the Gloucester fleet alone. Many of these families were left in utter destitution.

There can be but little doubt that upwards of 75 per cent of the vessels lost at sea meet with an untimely fate simply because they are too shallow; the consequence being that when caught in a gale they are

liable to be thrown on their beam ends, and, not being able to right because of their shallowness, fill and sink. In a single gale, that of December 9 and 10, 1876, no less than five Gloucester schooners were knocked down and barely escaped sinking. Three of them were dismantled, two of which were abandoned; one went into Liverpool, Nova Scotia, under a jury-rig; while the others were not so badly damaged. The inference is that other vessels that foundered in the same gale, and those that have been lost at sea on other occasions, were knocked down in a similar manner, and, failing to right again, soon sunk. Of course, with a deeper body to the vessels, and the ballast placed lower, there would be far less probability of such a mishap occurring, and even should it happen the chances would be a hundred to one that the vessel would right again. It is, therefore, altogether probable that the introduction of deeper fishing vessels in New England would save for Gloucester alone somewhere about \$30,000 to \$50,000 per year, besides a large number of lives.

As an instance showing how terrible the loss is sometimes, from the 29th of August to the last of December, 1883, 16 vessels from Gloucester foundered at sea, carrying down with them 205 men, while the loss of property was little less than \$100,000.*

19.—FISHERIES OF THE GULF OF MEXICO.

One of the subjects to which it is proposed to direct the work of the steamer Albatross hereafter is the investigation of the fisheries of the Gulf of Mexico. These, which a few years ago were very prolific, are rapidly diminishing in number, so that all along the coast between the mouth of the Mississippi and Pensacola a much larger number of boats and vessels are required to secure only half the supply that was obtained a few years since. The reduction applies mainly to sheepshead, salt-water trout, redfish, mullet, gray-snapper, &c. The decrease of the red-snapper is not quite so marked, but it is probable that it will in time take place even more rapidly than the others, as it is particularly

* Mr. R. B. Forbes, on the same subject, says: "I have perused with great interest the statements on the subject of the loss of life among the fishermen of Gloucester. The loss of 447 vessels and 2,600 lives in fifty-four years ending in 1884 is fearful to contemplate. In twenty-two years ending this year the number of men lost was 2,140. There must be some cause for this large increase. It may be presumed that the increase of the number of vessels in the business accounts for the increased loss of lives in a great degree. Another cause must be the fact that the vessels are more crowded. Another prominent cause must be the fact that trawl-fishing in dories necessarily exposes the men to greater danger than hand-fishing. I have before me a long list of men who have been separated from their vessels; many of these have been lost, while some have been rescued in a starving condition. No regular rule has been established for furnishing dories with condensed food and means for cooking. This should be done. Mr. D. W. Low, of Gloucester, has contrived means not only to feed persons, but to enable them to right their dories and to cling to them when capsized. If the owners of fishing craft do not feel interest enough to encourage the use of these means, there should be a law to compel them to do so."

sought after by fishermen. The cause of the decrease is probably partly overfishing in particular localities, and partly the numerous pestilences and mortalities by which so many are exterminated. No satisfactory theory has been presented for this mortality, although an intelligent writer suggests that it is due to the influx of the cold water found near the sea bottom at great depth even in the Gulf Stream, which has the same effect as the northers on the coast of Texas during the winter-time.

20.—TREATY OF WASHINGTON.

The termination of that part of the treaty of Washington relating to the fisheries is attracting much attention on the part of fishermen; and the question is being mooted as to how this is likely to affect American interests, and what should be done by the United States in the way of renewal. A proper investigation of the subject can be had only after a careful study of the influence the twelve-year period has had upon the welfare of the American fishermen and the amount of the catch. The U. S. Fish Commission has for some time been engaged in securing the data necessary to consider the subject fairly and thoroughly, should it be brought before a commission such as sat at Halifax in 1877.

21.—COD GILL-NETS.

The importance of the introduction, by the U. S. Fish Commission, of the method of catching codfish by the use of gill-nets, has never been so apparent as during the winter of 1882-'83. Owing to the almost total failure of the bait supply it was impracticable to carry on the shore cod-fishery by the old method of hook-and-line fishing. Such a scarcity of bait was never known before, and if the fishermen had not been instructed in the use of gill-nets for the capture of cod a valuable and important industry must have been almost abandoned for the season, at least while the scarcity of fresh cod in our markets would have increased the price to such an extent as practically to place this important article of food beyond the reach of the masses.

But during the previous two years the New England fishermen learned a great deal about catching codfish in nets from an illustrated pamphlet containing descriptions of all the methods, which was freely circulated by the Commission, and to this was also added the knowledge gained in a practical way. They were therefore prepared to meet the emergency, as, instead of being compelled to give up the shore cod-fishery, they met with a success which has rarely or never been equaled. Such excellent results obtained by the use of gill-nets in the cod fisheries that the local papers in the principal fishing ports contained frequent notices of successful catches. The Cape Ann Advertiser of December 8, 1882, gives the following account of the "Good results of net cod-fishing."

"On Tuesday, December 4, boat Equal, with two men, took 5,000 pounds of large codfish in seven nets off shore, sharing \$40 each. The

Rising Star has stocked \$1,200 the past fortnight fishing in Ipswich Bay. The Morrill Boy has shared \$101 to a man net-fishing off this shore the past three weeks."

The last mentioned schooner, the Morrill Boy, met with unexampled success, her crew of five men having shared \$320 apiece, clear of all expenses, by the last of December, the time employed being less than six weeks.

From the port of Gloucester alone, according to Capt. S. J. Martin, there were employed in the gill-net cod-fishery during December twenty vessels, carrying one hundred and twenty-four men and one hundred and seventy-six nets. In the period between November 19 and the last of December, 600,000 pounds of large shore codfish were landed in Gloucester, while 150,000 pounds were marketed at Rockport and Portsmouth, making a total of 750,000 pounds. When to this is added the amount which was probably taken by the vessels from Swampscott, Portsmouth, and other ports, it is perhaps safe to say that no less than 2,000,000 pounds of this highly valued and most excellent food-fish were taken by nets during the month of December and the latter part of November. The fish caught in nets were of extraordinary size, averaging more than 20 pounds each, while some individuals weighed as much as 60 or 75 pounds.*

During the previous two winters cod were taken in nets, with rare exceptions, only in Ipswich Bay, but this season they were caught very extensively on the rocky shoals in Massachusetts Bay. Since the beginning of January, however, the fish were most abundant in Ipswich Bay, and the fleet of shore cod-fishermen resorted to that locality, where they met with the most encouraging success, the catch during the first month of the year being, it is said, much larger than at any previous time.† The Cape Ann Advertiser of January 26, 1883, contains the following item in relation to this subject :

"The net cod-fishermen are meeting with good success in Ipswich Bay. On Thursday of last week three fares of handsome large codfish, nearly 30,000 pounds, were landed at Portsmouth."

An important matter for consideration in this connection is that not only can the cod fishery be successfully carried on even when bait is

* The above statements are based on the report of the Gloucester fisheries for November and December, by Capt. Stephen J. Martin, of the U. S. Fish Commission, pp. 159-161 of F. C. Bulletin, 1883.

† According to Captain Martin's report for January, 1883, 121,000 pounds of cod that were caught in gill-nets were landed in Gloucester during the month. Under date of February 6, 1883, he makes the statement that ten sail of small vessels, which had been fishing in Ipswich Bay, had landed at Rockport, Mass., and Portsmouth, N. H., during the previous twenty days, 230,000 pounds of large codfish. Calculating on this basis, the total catch of the whole fleet during the month of January would be very large. Owing to the fact, however, that no accurate and reliable statistics of the entire catch in gill-nets, along the whole coast, is obtainable, estimates must be based on the reports of the Gloucester fisheries, which have been carefully made by Captain Martin.

not obtainable—for, of course no bait is required when nets are used—but a very great saving is made in time and expense. As an instance of this it may be stated that the average bait-bill of a shore trawler would be not less than \$150 to \$250 per month when herring are so high-priced as they were this winter. Therefore it is safe to estimate that, when such a large fleet is employed in gill-netting as there was this season, the amount saved to the fishermen (which otherwise must be paid for bait) cannot be less than \$30,000 to \$40,000.

The day is now not far distant when the U. S. Fish Commission will be able to supplement what it has done, by propagating the cod on a very extensive scale, this having been found perfectly practicable.

C.—THE INCREASE OF FOOD-FISHES.

22.—BY PROTECTIVE MEASURES.

The question of the proper measure of protection to be given to fish, with a view of preventing their destruction or of securing their increase, is one that has occupied much attention during the past few years. The uncertainty as to whether the United States or the States themselves should enact the necessary legislation has in many cases prevented definite action.

Reference has already been made to the investigations of the Senate committee on fisheries in regard to the amount of protection to be given to the menhaden and bluefish, and the report of this body when issued will doubtless contain much that will be of great importance in the ultimate solution of the problem.

The subject of protection in the Great Lakes is also one that has been recently mooted by various legislatures and conventions, the question being somewhat complicated by the fact that a foreign nation for the most part owns the opposite shores, and that the question of the jurisdiction of the United States as against that of the States separately being, as already mentioned, still unsettled. There are thus three parties in the field, all of whom have to be considered in the inquiry.

Numerous complaints have reached the Commission in regard to the wasteful methods of capture, which seriously interfere with the proper maturing of the many young fish introduced into the lakes by the several States and the United States. These fish, only half grown, are said to be taken by the ton. The remedy suggested is to prohibit the use of any net of a mesh less than $4\frac{3}{4}$ or $4\frac{1}{2}$ inches. It is also suggested that the depth of water in which fishing should be carried on during the spawning season should be regulated.

The lake trout is also a sufferer by wasteful methods of capture; and it is sometimes taken in such quantities as to supply much more than the demand.

A meeting of fish commissioners of States bordering on the Great

Lakes was held at Detroit, October 17 and 18, 1883, to confer upon a better protection of the lake fisheries, uniform laws, artificial propagation, relation of the State commissions to the United States Commission, and the fishery authorities of Canada.

The United States Commission was represented by Mr. Frank N. Clark, who reported an interesting meeting. The following resolution was passed and transmitted to the U. S. Fish Commission:

Resolved, That this conference recommend and respectfully request the fish commissions of the different States bordering on the Great Lakes to urge upon their several senators and congressmen the advisability of securing some action by the United States Government, through the instrumentality of the U. S. Fish Commission, to induce the Commission to send one of its steamers with a sufficient force of scientific men to the Great Lakes, for the purpose of investigating the habits of the fish natural to those waters, the method of fishing pursued therein, and all other matters connected with the fishing industries."

23.—BY THE USE OF FISHWAYS.

Fishway over the Great Falls.—Reference has been made to this work in the previous report. Since then the surveys of the Great Falls have been completed, and a site has been selected for the construction of a suitable fishway which will enable shad, striped bass, and other food-fishes to ascend to the upper portion of the Potomac.

After careful consideration of the different varieties of construction offered, a plan of fishway suggested by Colonel McDonald has been adopted, and he has been instructed to have prepared the necessary working drawings for the purpose, to be submitted to contractors for estimates. Should this be within the appropriation, it will be recommended to the Secretary of War for such further action as he may think proper.

The early history of this fishway will be found in the report for 1882.

24.—BY THE DISTRIBUTION OF FISH AND EGGS.

As already explained in a previous part of the report, the method of distribution of fish and eggs has been almost entirely changed from service by means of messengers using the baggage cars of passenger trains, to the employment of cars built or fitted by the Commission expressly for the purpose. A great economy of service has been the result; and where a shipment of ten thousand was formerly possible, millions can now be sent. The work has been mainly under the direction of Colonel McDonald, to whose report in the appendix reference should be made for details. It may be stated, however, that the total number of applications for fish during the year was 10,060. These were mostly for carp. The actual distributions were, in brief, as follows:

Carp.—The total number of carp distributed during the year was 162,000 to 7,015 applicants. These were situated in every State and Territory, 292 congressional districts and 1,308 counties being repre-

sented. The distribution was made during the months of November and December, as being those in which fish can be transported with less danger of injury.

Shad.—The number of shad sent to a distance during the year amounted to 12,408,000, together with about half that number of her-
ring.

Whitefish.—The distribution of the whitefish obtained from eggs taken in 1883, was made for the most part from February to May of the following year; one of the cars being constantly employed during that period in transporting them from the hatchery at Northville, to a suitable point on the lakes. About 49,000,000 fish were thus transferred. The most prominent places of deposit in the Great Lakes were Manistee, Grand Haven, Traverse City, Port Huron, Ludington, Fort Gratiot, and Escanaba, in Michigan; Racine, Milwaukee, Sheboygan, and Ashland, in Wisconsin; North Bass Island, Put-in-Bay Island, and Ottawa City, in Ohio; and Erie in Pennsylvania; while a large number were planted in some interior waters of different States, either directly or through the State fish commissioners.

Of other members of the salmon family an extensive distribution was also made, the details of which will be found in the several special reports. The eggs of these were obtained from Grand Lake Stream and Bucksport in Maine, the trout ponds on the McCloud River, California, and at Northville, Mich., and Wytheville, Va.

25.—SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1883.

- a. The codfish (*Gadus morrhua*).
- b. The Spanish mackerel (*Scomberomorus maculatus*).
- c. The rockfish or striped bass (*Roccus lineatus*).
- d. The mullets (*Mugil*).
- e. The whitefish (*Coregonus clupeiformis*).
- f. The brook trout (*Salvelinus fontinalis*).
- g. The lake trout (*Salvelinus namaycush*).
- h. The saibling (*Salmo salvelinus*).
- i. The California, rainbow, or mountain trout (*Salmo irideus*).
- j. The Atlantic or Penobscot salmon (*Salmo salar*).
- k. The Schoodic or landlocked salmon (*Salmo salar* subsp. *sebago*).
- l. The European trout (*Salmo fario*).
- m. The quinnat or California salmon (*Oncorhynchus chouicha*).
- n. The shad (*Clupea sapidissima*).
- o. The carp (*Cyprinus carpio*).
- p. The goldfish (*Carassius auratus*).
- q. The golden ide or orf (*Leuciscus idus*).
- r. The tench (*Tinca vulgaris*).
- s. The catfish (*Amiurus*).
- t. The clams.
- u. The American lobster (*Homarus americanus*).
- v. The oyster (*Ostrea virginica*).

a. **The Codfish** (*Gadus morrhua*).

The Fulton Market (New York City) Station.—As referred to in previous reports, a renewed effort was made to utilize the live spawning codfish brought in during the winter season to Fulton Market, the necessary facilities in the way of a station being furnished by Mr. E. G. Blackford, fish commissioner of New York. The work was begun on January 8, and by the 11th 4,000,000 sound eggs were obtained. A reasonable number of these were hatched out and deposited, but further operations for the winter were prevented in consequence of the destruction of the adult fish by slush ice in the East River. Mr. S. I. Kimball, Superintendent of the Life-Saving Service, on application of the Commission, kindly ordered the crew of the life-saving stations on Long Island to assist in collecting eggs of cod should they be procurable.

On a previous page reference has been made to the continued life history of the school of cod hatched out at Gloucester in 1878-'79. It is not improbable that the fish first hatched out have reproduced their kind, as young gray cod of two sizes are now taken during the summer on the coast. In 1882 they were abundant off Portsmouth, N. H., the fishermen being satisfied that they were the result of the work of the Commission. During the summer of 1883 numbers were taken in the mouth of Gloucester Harbor, one man capturing 70 or 80 pounds on a mackerel line, the fish weighing from half a pound to 2½ pounds each. It would seem from these statements that not only have these fish been successfully planted, but also that they have changed their habits and are likely to continue to be an inshore summer fish, which is of course a desideratum of very great importance. A note given below from Mr. R. S. Tarr, an intelligent naturalist and resident of Gloucester, contains further information on this subject.*

* While in Gloucester recently I made some inquiries in regard to the report that small cod of the species *Gadus morrhua* were very abundant in the harbor. Although I was there in the wrong season, still I think that I gained enough information to establish beyond a doubt that small cod, some as large as 14 inches in length, belonging to *G. morrhua*, are extremely abundant at Gloucester; and as these belong to the species which is at present almost entirely deep-sea, it seems evident that we must look to some other causes than natural ones to explain the appearance of such great numbers in so small an area, for as far as I can find out only one other school has been seen along the New England coast in shallow water. I talked with several fishermen, and they all reported the abundance of the "silver-gray cod," which could not be distinguished by them from the deep-sea cod. The most intelligent and observing of all with whom I spoke was Mr. Edwin F. Parsons, of East Gloucester, who expressed a willingness to correspond with you upon the subject, and also to make preparations of specimens, under your direction, if you desired it.

He told me that in the spring and summer for the two past seasons, while fishing for bait for his lobster traps, he took great numbers just outside of Ten-Pound Island. Their abundance dwindled down until in February they were least abundant. Last spring the largest fish weighed 4 or 5 pounds, and often in a day 100 pounds would be the result of his catch. He did not fish especially for these, but simply for bait for his traps. The cod he would sell, while the other fish would serve his purpose. He thinks that he can see three generations, the largest weighing 5 pounds and the

b. The Spanish Mackerel (*Scomberomorus maculatus*).

The Fish Hawk Station.—An effort was made during the present summer to hatch eggs of the Spanish mackerel in the Chesapeake Bay on board the steamer Fish Hawk, under the command of Lieut. W. M. Wood. The vessel was occupied in the work from June 21 to August 13, the first ripe spawn being obtained at Mobjack Bay on the first-mentioned date. During the month of July the fishermen were very successful with their nets in taking fish, but it was found difficult to obtain ripe eggs among them. In all, 6,500,000 eggs were taken in June and July and placed in the cones for hatching. The result was, however, in every instance a loss of the eggs, except on July 4th, 250,000 hatched and were returned to the water. Lieutenant Wood, in his report in the appendix, has given an account of the efforts made, and, together with Dr. Kite, has described the apparatus made use of for hatching.

c. The Rockfish or Striped Bass (*Roccus lineatus*).

In view of the rapid decrease in the abundance and size of striped

others considerably smaller. Although he has been fishing for seven or eight years, never before 1882 did he find deep-sea cod in any numbers inside of Gloucester Harbor. Taking into account this fact, Mr. Parsons feels confident that they can be no other than the fish put into the harbor in 1879; and he wished me to say that he feels thankful for the money he had made and the chowders he has had, as he expressed it, at the expense of the Fish Commission. Considerable enthusiasm is expressed among the fishermen in regard to this matter, and they feel anxious that the work started in 1878 shall be continued. Not only are these fish caught in the outer harbor, but even in the innermost docks of the inner harbor, boys, while fishing for flounders, frequently land gray cod. This is extremely remarkable—that such cod should be found in the very impure water of the docks. But still this is asserted by many. My cousin, Mr. Spinney, who for many years was a practical fisherman and a good observer, and now the head of a firm which handles thousands of cod every month, has examined them critically and compared them with deep-sea cod, and said positively that they were the same. The specimen sent by Mr. Wonson is *G. morrhua*. If you wish specimens in alcohol, Mr. Spinney will obtain any that you want upon receiving directions from you. Mr. Spinney sees nearly all the cod which enter Gloucester, and upon being asked if the gray cod was found at other points along the coast he said that the only instance that he knew of was the case of a vessel which had just landed 15 barrels of cod taken in shallow water near Mount Desert. I went to the wharf and found the fish, which proved to be *morrhua*, 14 inches long. I obtained two specimens for the National Museum. They seemed to run about the same size, varying about 1 inch in length, and correspond in size almost exactly with the specimens taken at Gloucester. These may be a portion of the cod from Gloucester emigrating from their original home. As this was the only case which I could find of the *G. morrhua* being found in shallow water, outside of Gloucester, I am inclined to the opinion that they are but an offshoot of the Gloucester cod.

Another recognized good caused by the Fish Commission while at Gloucester is in regard to the reddening of fish. I was informed by several fish-dealers who have adopted your suggestion to use Trepani salt instead of Cadiz, that not a single instance of reddening has occurred during the past summer. The butts used for pickling the fish exhibited a tendency to turn red only when they had previously been saturated with Cadiz salt.

bass on the coast the Fish Commission has been desirous of increasing the supply by artificial propagation, but the difficulty of finding the ripe parent fish has hitherto been a barrier in the way. At the request of the Commission Mr. S. G. Worth, superintendent of fisheries of North Carolina, made some experiments at Weldon, in that State, and found that it was practicable to secure quite a number of the breeding fish. He hatched out many of them successfully, and obtained data enough to warrant the hope that the work might be done on a much larger and more efficient scale hereafter.

In June, 1882, as previously recorded, with a view of determining whether the rockfish or striped bass could be kept in pens until their eggs should ripen, a large number were placed in the pool at Battery Station, near Havre de Grace. No fish larger than 8 pounds were secured, so no results were obtained. Some of them, however, lived into the summer of 1883, but as they were not adult, and no effort was made to feed them they were found to be in poor condition.

It may be remembered that several years ago the fish commissioners of California secured the services of Mr. Livingston Stone to transport a number of young striped bass to California waters. Since then report has been made of captures of these fish, one of them on November 7, at San Francisco, weighing 17 pounds.

d. The Mullet (Mugil).

Several species of this genus occur very abundantly on the southern coast, so much so, indeed, as to constitute a special fishery; but nothing has been done in regard to introducing them to other waters. They are found in small numbers eastward, Vineyard Sound being perhaps the limit of their occurrence in that direction. Here, however, they are small and of no commercial value. Some species thrive in fresh water. The experiment has been made by the California fish commissioners of transporting a Sandwich Island species into that State, although I have no report as to the general result. This fish is propagated in the harbor of Honolulu, being reared in artificial ponds made in the salt marsh lands near that city, and large quantities are obtained there for the market. They are much esteemed as an article of food, and the subject is one that will be deserving of future consideration.

e. The Whitefish (Coregonus clupeiformis).

The Northville Station.—The anticipations excited by the great success of this station in previous years were fully met during 1883, under the continued supervision of Mr. Frank N. Clark. Perhaps the most important improvement this year in the arrangements for hatching consisted in the introduction of the McDonald jars, which proved an entire success and suited to the enlarged operations of the station. The water supply was thought not to be sufficient for increasing the old method of service, but the economy of these jars, which permitted the water to be used over and over, rendered the fears groundless. The

first instalment of whitefish eggs was received November 14 from Lake Erie, and the last was received December 1. A heavy storm in the middle of November made it necessary to abandon Lake Erie, and the bulk of the eggs was obtained from Lake Huron, the principal places being at the mouth of Thunder Bay. Some very heavy catches of whitefish were made on the Canada side around Duck Island, one propeller having on board 45 tons of whitefish at a single time. These whitefish were large, specimens weighing from 15 to 20 pounds being frequently taken, and the largest weighing 26 pounds. The experiment of holding adult whitefish in inclosures until the eggs were ripe was renewed, and proved as successful as it had been during the previous years. The fish were kept in floating crates at North Bass Island, in Lake Erie, and at Alcona, in Lake Huron. The crates were anchored about 20 rods from the beach, in 12 feet of water. From the fish confined therein 5,000,000 eggs were taken, and not a fish died while confined in the crates.

During the season 25,000,000 eggs were brought from the fisheries direct to Northville. There were transferred from the Alpena Station 35,000,000 eggs, making a total of 60,000,000 handled at this station. Of this number 12,000,000 were sent away and 8,000,000 were lost in various ways, the total number hatched at this station being 40,000,000. Of the 12,000,000 eggs which were removed 1,000,000 were sent to Germany, 1,000,000 to New Zealand, and the remainder to State and national hatcheries. Those sent to foreign countries reached their destinations in good condition; those for New Zealand having been received at San Francisco and forwarded by Mr. R. G. Creighton, and those for Germany having been repacked and forwarded from New York by Mr. Fred Mather.

The young whitefish began to hatch out on the 16th of February. On the 20th, car No. 2, in charge of Mr. Ellis, was loaded with 3,000,000 eggs to be taken to Manistee. The car made trips back and forth from the Great Lakes until all were disposed of.

Quite extensive operations were prosecuted at this station in brook trout, lake trout, rainbow trout, and German trout, which will be treated under their proper heads.

The Alpena Station.—This station was supplied with both the McDonald and Chase jars, and the water supply obtained from the city water-works. Not being, however, upon a railroad it was necessary to transfer 35,000,000 of eggs to the Northville hatchery in order to avoid moving live fish. The supply of eggs which was derived from 68 pound-nets and numerous gill-nets, filled 375 jars. Of these 32,000,000 were hatched at Alpena, and the remainder sent to Northville. The fry hatched at Alpena were planted mostly on the west coast of Lake Huron in April, 1884.

The question has arisen as to whether it is better to deposit the young fry of whitefish and other salmonidæ in distant waters, as soon as the

yelk bag is absorbed, or to keep them until they have attained considerable size, and can better protect themselves against their enemies. When, however, fish are cultivated on the scale adopted by the Fish Commission, it is almost impossible to find the necessary inclosures where they would have sufficient room, or to supply the food that they would consume. For if 100 fish would devour an ounce of food each day, 1,000,000 would consume about 600 pounds, or 108,000 pounds in six months. The estimate in this case is probably much below the actual figures.

Another point is as to the length of time it should take to hatch out the eggs, whether it would be better to use warm water from springs to accelerate this result or to retard it by applying the colder water of the lakes. This question has not yet been satisfactorily decided, the action of the fish commissioners of the States varying in this respect.

f. The Brook Trout (*Salvelinus fontinalis*).

The Northville Station.—During the season between October 10 and November 21, there were taken from the creeks near the hatchery 200 brook trout, of which 33 were found to be ripe females, and which yielded 18,000 eggs.

There were in the station some 10,000 fry, 2,000 yearlings, 500 two-year-old trout, and 500 three and four-year-olds. From these fish a large number of eggs were taken. Of these, 25,000 were sent to Germany, 150,000 to Washington, and smaller numbers to various State hatcheries. The eggs taken from the wild trout were hatched, and the fry returned to the streams.

Ten thousand trout eggs from the 1882 stock were forwarded, January 13, to E. G. Blackford for transmission to Bogota, U. S. of Colombia.

g. The Lake Trout (*Salvelinus namaycush*).

The Northville station.—A large number of lake trout were captured in Lake Erie, the best days being early in November. The fish spawned this season much later than usual. Although no eggs were taken after November 18, a good many fish were reported as yet unripe. There were 280,000 eggs taken, of which 25,000 were sent to Germany and 100,000 to Washington. There were also 105,000 eggs at Northville, and the young distributed by car No. 2 to Strawberry Lake, Star Lake, and Crooked Lake, in Northern Michigan. The remainder were deposited in Arnold's Lake, in Washtenaw County.

The lake trout promises to be an important inhabitant of cool lakes, and even of flowing streams. The young exchanged with fish-culturists in France and Germany have succeeded very well, and give great satisfaction. Numerous letters are on file in the office of the Commission making grateful acknowledgment of the favor.

h. The Saibling (*Salmo salvelinus*).

Among the most highly esteemed species of the trout family of Europe is the saibling, known in England as char and in France as *ombre*

chevalier. Through the courtesy of the president of the *Deutsche Fischerei-Verein* a number of the eggs were received in January, 1881, and sent to the fish commissioners of New Hampshire, at Plymouth, for development. They proved hardy and grew satisfactorily, and on December 3 of the present year about 600 eggs were taken by Commissioner Hodge. These will be transferred to another station, to be hatched and reared; and it is hoped that the species may in time become well known in this country. The fish is specially adapted to the deep waters of cold lakes, being very abundant in the Geneva and other lakes of Switzerland.

i. The California, Rainbow, or Mountain Trout (*Salmo irideus*).

The McCloud River Station.—The season for taking trout eggs opened on January 3 and continued until the 5th of April, when it was found that from over 33 spawning females 388,000 eggs had been taken. Mr. Loren W. Green was more particularly in charge of this station, although Mr. Stone retained the general supervision, and the latter states that Mr. Green is entitled to great credit for the endurance and perseverance exhibited in his work.

Each year a number of parent trout are taken from the river for the purpose of replenishing the trout ponds and to make up for the yearly losses sustained. This season, for the first time, several thousand young trout were reserved in the hatching troughs, and, later, 12,000 were placed in a pond by themselves to be reared for breeders. This necessitated some new ponds, which were built during the year. In order to help maintain the supply 20,000 fry were turned loose in the river. Of eggs there were lost during the various operations but 24,000, and the remainder, 332,000, were forwarded to Washington and various State hatcheries. For further details of the work reference may be made to the report of Mr. Stone in the appendix, where will be found some interesting remarks upon the abundance of panthers, wild-cats, lynxes, raccoons, minks, otters, and other frequenters of the region.

The Northville Station.—It has been found that since the rainbow trout were brought from California to this station their habits have so far changed that they have become winter spawners. Mr. Clark believes that in a few years they will spawn simultaneously with the brook trout. In January and February he took 125,000 eggs, but only succeeded in fertilizing one-fourth of them. He shipped 12,000 eggs to Mr. Mather for Germany, 3,000 for France, and 3,000 for England. He hatched 10,000 fry, which were planted in Indiana, Michigan, and Ohio. There was also received a case of 4,000 rainbow-trout eggs on March 18 from the McCloud River station. These arrived in prime condition, and the fry which were hatched from them were added to the breeding stock. Two new trout ponds were completed in June of the present year.

The introduction of the California trout to Eastern waters was first

made in a practical manner by the New York fish commission, its well-known superintendent, Mr. Seth Green, having brought a number from the McCloud River to the State hatchery at Caledonia, from which to obtain eggs for distribution in various waters in the State of New York. Subsequently the U. S. Fish Commission established the ponds on the McCloud River, of which such frequent mention has been made in previous reports. The rapid growth and game qualities of this fish, and its adaptation to many waters where the brook trout will not thrive, have caused the great demand which it is not easy to supply, but which the Fish Commission is now endeavoring to meet as far as possible. Reports from various quarters on this fish are very satisfactory. By planting them in public waters they are likely to extend over a wide area, and furnish to all an opportunity for capturing them. A specimen caught in the free water of the Roanoke River of Virginia weighed about 10 ounces. It was the product of an egg hatched about two years before.

j. The Atlantic or Penobscot Salmon (Salmo salar).

The Bucksport Station.—Mr. Charles G. Atkins continues in charge of this station, and, as heretofore, the operations were conducted jointly by the United States and the Maine and Massachusetts Fish Commissions. As heretofore, the breeding salmon were purchased from the Penobscot River fishermen. There were secured 431, which averaged 18 pounds in weight, this being about 5 pounds heavier than the average of the previous year. It was found, however, that the large salmon were much more susceptible to injury from handling than smaller ones, so that of the 431 purchased but 267 reached the breeding ponds. There was an unusual proportion of female fish, and, as already indicated, they were of extraordinary size. Consequently the spawning operations which lasted from October 29 to November 7 resulted in the taking of 2,535,000 eggs, an average of 12,000 to the fish. Prior to shipment between 4 and 5 per cent were found defective, leaving 2,420,000 sound eggs. A pro rata division of these gave to the United States 1,370,000, to Maine 700,000, and to Massachusetts 750,000. From the United States quota 500,000 eggs were sent to the Cold Spring Harbor Hatchery, which were incubated with very slight loss, and were planted in several New York streams. Of the 100,000 sent to Wytheville, 50,000 were hatched and planted in the Oswego River, and the remainder were retained at the hatchery. From the Maine quota large deposits were made in the Androscoggin River, Crooked River, Webb's River, Sandy River, Piscataway River, Mattawamkeag River, and the Denny's River. Thirty thousand were sent to Northville.

The Northville Station.—On February 28, a case of 30,000 Penobscot salmon eggs was received from Bucksport, Me., which on being unpacked, were found in good condition. The fish hatched out between March 16 and March 24, the loss being but about 600. Over 29,000

were planted on May 25 in the headwaters on the Huron River, in Oakland County, Michigan.

k. The Schoodic or landlocked Salmon (*Salmo salar* subsp. *sebago*).

The Grand Lake Stream Station.—This station, which continues in charge of Mr. Charles G. Atkins, was eminently successful during 1883. During the fishing season which existed from October 29 to November 20 there were taken only 1,005 fish, of which 709 were females and 296 males. As with the salmon, however, they proved to be large and prolific. From the 661 females found to be ripe 1,070,500 eggs were secured, an average of 1,623 to each female. The heaviest female weighed 8.8 pounds, and the heaviest male 5.4 pounds. The new hatchery, which was erected in 1882, proved very useful, and the eggs taken were divided between the two hatcheries, the one fed by spring water and the other by lake water. After the removal of the unfertilized and other imperfect eggs, there remained 960,000 for use. Of these 240,000 were set aside as a reserve, 373,000 assigned to the United States, 133,500 to Maine, 133,500 to Massachusetts, and 80,000 to New Hampshire, this being in proportion to the funds contributed by each.

From the United States quota, 5,000 eggs were sent to New York, and forwarded by Mr. Fred Mather, by the steamer Baltic, to Sir James G. Maitland, Stirling, Scotland. The remainder of the United States lot was assigned to State commissioners, some thirteen different States sharing in the distribution. In general, these eggs reached their destination in good order, and were successfully hatched and deposited in suitable waters, the full details of which will be found in a table appended to Mr. Atkins's report.

It has so far proved almost impossible to meet the call for eggs or young of this fish.

l. The European Trout (*Salmo fario*).

Eggs of this species were received from Mr. Von Behr, the president of the *Deutsche Fischerei-Verein*, in the winter of 1882-'83, and were sent directly from New York to the station at Northville, where they arrived on February 18. The eggs were successfully hatched out by Mr. Clark by the middle of March, and early in April were planted by him in a branch of the Pere Marquette River of Northern Michigan.

The European trout is an excellent table fish, and attains a much larger growth than the species found in the United States, a weight of from 10 to 20 pounds being not unusual. It is hoped that it may be available for some localities not so well fitted for the brook trout, where, by its rapid growth and the size to which it attains, it may constitute an important article of food.

m. The Quinnet or California Salmon (*Oncorhynchus tshawytscha*).

The McCloud River Station.—An unprecedented and unforeseen condition of things was experienced at this station during the present

year. The hatchery was put in order at the usual time, and an annex 80 feet long by 8 feet wide was built for the purpose of accommodating an additional 2,000,000 salmon eggs for the California commission. When the time came for salmon to arrive, few if any were to be found. Mr. Livingston Stone, who is still in charge of this station, arrived at the station August 1, and on the 7th of August, when it was expected that 500 or 1,000 salmon would be taken, but one specimen, and that a small one, was caught. As the days passed on the numbers continued very small; and it was not possible to secure during the latter time more than 1,000,000 eggs, and a careful investigation was made of the cause of the scarcity. It was found that from 3,000 to 6,000 Chinamen were at work on the California and Oregon Railroad, which runs along the Sacramento River, 8 or 10 miles below the hatchery. The blasting operations of the railroad company were on a gigantic scale, it being stated on good authority that two six-horse wagon loads of gunpowder were used at a single blast, and that this blasting was kept up day and night. Mr. Stone considers this blasting to be an ample explanation of the failure of the salmon to ascend the river. But it was also alleged, with some show of truth, that the Chinamen did a very large business in capturing fish below, while they were at work, by exploding giant powder in the river. As before stated, but 1,000,000 eggs could be obtained. These were handled with great care, but on the 19th of September an accident happened to the wheel, which cut off the supply of water, and 25 per cent of the eggs were lost before the necessary changes could be made. The remainder were turned over to the California fish commission on the 6th of October, to be hatched and returned to California waters.

In addition to the scarcity of salmon in the McCloud, which was attributed to the operations on the railroad, it was discovered that there were very few salmon in the Spokane River. This was the cause of considerable consternation to the Indians who annually encamped near Spokane Falls in anticipation of a large run. Up to October 1, they had obtained not more than a few dozen fish, while in 1882, a traveler reported seeing from 40,000 to 50,000 salmon drying at one time under the care of the Indians.

The catch of salmon at the canneries on the Sacramento River was fully up to that of the previous year. The total for the year ending October 15, 1883, was stated to be 451,957 spring salmon and 160,542 fall salmon, weighing 7,349,988 pounds, delivered to the different fishing firms. The wholesale dealers received 115,004 spring salmon and 52,902 fall salmon, making a grand total of 780,405 salmon, weighing 9,585,672 pounds.

The average yield of the canneries on the Sacramento for the years 1881, 1882, and 1883 was 9,596,984 pounds. The average yield for 1875 and 1876, before any fruits of fish-culture could have appeared, was 5,205,102 pounds, a net gain per annum of 4,391,882 pounds.

A small consignment of salmon eggs, for experimental purposes, was forwarded from California to Washington by express, arriving October 4. The long time they had been on the way, with perhaps insufficient care in transit, caused the loss of the entire lot from overheating.

n. The Shad (*Clupea sapidissima*).

With a view of ascertaining what could be done in the southern waters in the way of hatching shad, Mr. Ferguson started on board the steamer Lookout, and arrived at the mouth of the Saint Mary's March 20, from which point he proceeded to the Saint Mary's River and made a careful examination of it as far as Clark's Bluff, a distance of 30 miles. At this point the nets of Mr. Pierson were being fished with a result on the average of 100 shad per day, several ripe ones being found among them. Having ascertained that good hatching work could be done on this river, the Lookout next proceeded to the Saint John's River, which was reached on the 22d of March. On the way to Jacksonville many gill-nets set for shad were observed, but there was a complaint of the scarcity of fish. Yellow Bluff, a small settlement below Jacksonville, was found to be the center of the shad fishing on the Saint John's River. At Jacksonville the shad in the market appeared to be about a week or ten days from maturity. From Jacksonville the steamer proceeded to Palatka and Lake Monroe, where small shad-fisheries were found. Returning on the 27th, the vessel left Jacksonville on the 28th, and after a stop at Saint Augustine arrived in Washington April 19. For successful work on the Saint Mary's it was decided that everything should be in readiness for operations by the 1st of March.

During this season the following stations have been occupied for the purpose of hatching shad and herring on the Potomac and Susquehanna: (1) Quantico and Glymont by the Fish Hawk; (2) Fort Washington for collecting the eggs; (3) Central Station for hatching eggs brought from the river; (4) Battery Station, Havre de Grace.

Quantico Station.—Having taken on board the usual shad-hatching outfit the Fish Hawk, under Lieutenant Wood, left the navy-yard, April 12, for the mouth of Quantico Creek, for the purpose of establishing a station for hatching eggs of shad, herring, perch, &c. On the next day Lieutenant Wood visited the fisheries within reach, and found that Budd's Ferry was not being fished at all; that Stump Neck fishery would begin shortly; that the Freestone Point fishery was in full operation and doing well, 400 and 600 shad having been caught in two hauls that day, as well as 10,000 herring. The fish, however, were found to be unripe, and the temperature of the water 60°. There were taken, however, that day 50,000 eggs from a herring. On the 24th of April Lieutenant Wood reported, that owing to a protracted rain, the temperature had fallen to 50, and had completely arrested the development of the eggs in the cones. Young herring, estimated at 600,000 in number, were put in the river that day (the change of temperature killed about

7,000,000 others). The water continued cold, and very little being accomplished, the vessel was moved higher up the river, to Glymont, May 7, where it was continuously engaged until the 28th of May, when it returned to the navy-yard. On the 8th of May Lieutenant Wood reported having taken 12,000,000 eggs of herring, 60,000 of perch, and 7,000 of shad.

Fort Washington Station.—This station was placed in charge of Lieut. William C. Babcock, U. S. Navy, and the Secretary of War having given the desired permission to occupy the grounds and buildings, the work began April 14. Some difficulty was found in inducing the fishermen to co-operate. Mr. L. G. Harron was permitted to fish the Fort Washington shore on condition of supplying eggs to the Commission. The fishing shores of Moxley's and Brant's Points, Ferry Landing, and White House were visited regularly during the season, which on the whole was a bad one, being interrupted by rains and change of temperature of the water. Lieutenant Babcock, however, was able to obtain 21,850,000 eggs. The first eggs, 64,000 in number, were taken April 14. The greatest number of any one day (1,140,000) were taken May 19. On the 21st of May Mr. Harron violated his contract and withdrew his seine, when it became necessary for the Commission to put its own net into the water and to haul it during the remainder of the season. This was done very successfully, and a larger average of shad were taken in it than had been taken in Mr. Harron's seine. The last eggs taken during the season were 15,000, June 10, when seining was discontinued; and on the 13th all of the eggs were transferred to Central Station, as during the early portion of the season the river steamers were depended upon for transportation. After the 8th of May the Lookout was at the disposition of Lieutenant Babcock, and enabled him to turn the eggs over much more promptly to be hatched. Lieutenant Babcock was assisted by Mr. John Lucket, in charge of the seine, and by Mr. James Carswell, who had immediate charge of the spawn-takers. His report will be found in the appendix.

Central Station.—This station was used for hatching the eggs sent up from Fort Washington. The young fish when ready for shipment were transferred directly from the hatching apparatus to the cars. This was great saving of time and of risk and expense of removal by wagons.

Battery Island Station.—The arrangement of the grounds, buildings, and other improvements made at this island for the purpose of utilizing the extensive fisheries in the vicinity, were quite fully described in the report for 1882.

The management of this station for 1883 was placed in charge of Lieut. W. F. Low, U. S. N., who was furnished with a seine 906 fathoms in length, to be operated by steam, and a force of 30 men. On the 19th of April the first shad eggs, 25,000, were secured, and other were obtained on the following day. From the 22d to the 27th of April it was impossible to accomplish anything; after that, however,

eggs were obtained daily, during the remainder of the season. The shad caught, if not ripe enough for spawning purposes, were placed in a large pool or reservoir until they became so, and were then caught and stripped. On the 12th of May, Mr. Frank N. Clark, of Northville, visited this station for the purpose of observing particularly the effects upon the shad of their being penned during this stage. His report will be found in the appendix. His experiments appended show that the female shad is extremely sensitive to the least interference with its method of reproduction; and that under certain circumstances injuries will result. Some of the shad with roe particularly affected as the result of confinement in the pool were sent to Mr. John A. Ryder, at Washington, the biologist of the Commission. He discovered certain abnormal appearances with a peculiar tendency toward fluidity. He decided that impregnating such ova would be out of the question.

On the 4th of June, Lieutenant Low was relieved from duty at this station, and Mr. Frank N. Clark placed in charge thereof. Lieutenant Low had collected 6,363,500 eggs, had deposited in local waters 3,751,500 fish, and delivered to be distributed by the Fish Commission messengers 1,633,000 fish.

From June 4th to June 8th Mr. Clark collected 1,096,000 eggs, from which there were hatched 768,500 fish, of which 521,500 fish were planted in the bay, and the rest delivered to the Fish Commission messengers.*

A pamphlet of three pages, entitled "Inducements offered fishermen to furnish shad eggs for the U. S. Commission of Fish and Fisheries," prepared by Lieutenant Babcock, was issued to shad fishermen during the season. In this, full instructions were given for stripping shad and caring for the eggs. It was also stated that the necessary apparatus would be furnished upon application to the Armory building in Washington and on board the steamers, and that a liberal price would be paid to the gillers, pound-net, and seine fishermen for eggs taken according to the instructions and delivered on board the steamers of the Commission as they made their daily trips. The instructions were also published in the Bulletin of the Fish Commission, vol. ii, page 389.

This season the experiment of shipping shad eggs by express on trays covered with wet cloths was first tried by Colonel McDonald. A lot of eggs thus sent to S. G. Worth, Raleigh, N. C., reached their destination in excellent condition.

*The shad fisheries of Havre de Grace in 1883 were reported to have given occupation to 259 men, 6 engines, and 15 horses, using 4,217 fathoms of seine. The number of shad taken was 46,967. These were sold mostly in Philadelphia, the Baltimore market being supplied by day fishermen. In addition to the shad which were seined, 16,500 were caught in gill-nets, making a total for Havre de Grace of 62,967 shad. The statistics of all the fisheries of the Susquehanna and at the mouth of the Chesapeake, could they have been obtained, would probably have shown a total catch of 100,000 shad for the season.

o. **The Carp** (*Cyprinus carpio*).

The work connected with the carp may be considered among the most important of the operations of the Commission. The good results have been manifested over the entire country and the demand for the species is increasing year by year. The history of the fish is given in ample detail up to date in previous reports, and it is sufficient here to recall the fact that they are all produced in the city of Washington, for the most part in the ponds at the foot of the Washington Monument, though a portion are raised in the ponds near the Washington Arsenal, the occupation of which has been sanctioned by the War Department. The scale carp are cultivated exclusively at the Arsenal ponds, while the mirror and leather varieties are reared in the Monument ponds.

The area of the Arsenal ponds is about one-fourth of an acre; that of the Monument ponds is given in the accompanying foot-note.*

The increasing demand for carp has made it necessary to extend the facilities for raising them, and an arrangement was entered into for making some new ponds along the line of Virginia avenue, which it is hoped will be ready in time for service in 1884.

The attention of the Commission has been attracted for some time to a new race of carp known as the blue carp, which was supposed to be

*ELEVATIONS.—Curves of elevation above mean high water are shown for differences of 1 foot; the heights are given in feet.

BENCH-MARK.—The top of the brick wall at the southeast corner of the south wall of the north gate chamber of west pond is 2.875 feet above mean high water of the Potomac River, and was established by the city engineers.

AREAS.		Acrea.
East pond		6.437
West pond (water surface, 6.642 acres; two islands, 0.403 acre).....		7.045
North pond	4.346	
South pond	1.500	
Pond No. 1 .....	.078	
Pond No. 2 .....	.086	
Pond No. 5 .....	.157	
Pond No. 6 .....	.178	
Remainder of island, including turtle pond, tanks, ponds Nos. 3 and 4...	.576	
Total of north and south ponds combined, including the island between.		6.921
Ground between east pond and B street	2.301	
Ground between east pond and Executive avenue .....	.882	
Ground between north pond and B street .....	.229	
Ground between north pond and Seventeenth street .....	.349	
Ground between north pond and Executive avenue .....	.280	
Ground between west pond and Executive avenue	2.354	
Ground between west pond and Potomac River .....	.219	
Ground between west pond and Seventeenth street .....	.160	
Seventeenth street from B street to Potomac River	2.989	
Virginia avenue, as inclosed	2.438	
Grand total		30.604

preferable in some respects to the other varieties. Through the courtesy of the *Deutsche Fischerei-Verein*, a number of specimens were received and placed in the ponds. They will be isolated from the other varieties, and their young will be distributed to such persons as wish to have them.

Much trouble is experienced at the United States carp ponds from the attacks of birds, rats, and snakes, the attention of the superintendent and his assistants being constantly occupied in destroying them. During the year more than a thousand water-snakes were destroyed, mostly by shooting them. Many fish-hawks, kingfishers, night-herons, &c., were also killed.

p. The Goldfish (*Carassius auratus*).

Central Station.—Goldfish were raised as usual, in large numbers, at the carp ponds under the direction of Mr. Hessel.

During this year there were 5,001 goldfish distributed to 802 applicants, in thirty-three States and Territories.

q. The Golden Ide or Orf (*Leuciscus idus*).

This ornamental fish, which occurs in great variety and is very attractive, is cultivated by the Commission for distribution. It attains a length of about 18 inches, is of a beautiful orange red when seen from above, and silvery when observed laterally. It is continually in motion and swims round in schools close to the surface of the water, being in this respect much preferable to the goldfish. It has proved to be a very delicate fish, and though quite a number have been raised and distributed, serious losses are experienced by the cold snaps which kill the eggs.

r. The Tench (*Tinca vulgaris*).

A small number of tench are cultivated in the Washington ponds, but there is little demand for them.

s. The Catfish (*Amiurus*).

In previous reports reference has been made to the successful introduction of the catfish (*Amiurus nebulosus*) into the waters of California, their multiplication, and the very high esteem in which the fish has been held as an article of food. Specimens have been taken from that State to Nevada by Mr. Parker, fish commissioner of the latter State, where it bids fair to multiply. There are quite a number of species from which a selection may be made, and there is every reason to believe that the fish will in time be in great demand among fish-culturists.

Mr. J. F. Jones, of Hogansville, Ga., has been cultivating one of the Southern species and considers it a very important food-fish, growing very rapidly, living on vegetable substances, and spawning when one year old. A fuller statement of Mr. Jones's experience with this fish will be found on page 321 of vol. iv of the Fish Commission Bulletin.

t. The Clams.

The occurrence on the Pacific coast of the United States of several species of edible clams of very great value has induced the Commission to inquire into the propriety and importance of transplanting them to the waters of the Atlantic, and Mr. R. E. C. Stearns, an eminent conchologist, was requested to visit the localities and make a report upon the subject. As the result of his inquiry he finds that several species are worthy of consideration, especially one of them which normally weighs 4 pounds and occasionally as much as 18. As soon as practicable, the necessary effort will be made for their transplantation. Little if anything, however, can be done until there is railway service to the localities in Washington Territory where the clams can be most readily obtained. A report made by Mr. Stearns on the subject of these clams, with illustrations of the several species, will be found in the Fish Commission Bulletin for 1883.

u. The American Lobster (*Homarus americanus*).

The highly-prized American lobster, which occurs from Labrador to Delaware Bay, although most abundant in New England, and formerly so plentiful, is now becoming scarce, and much apprehension is felt as to the danger of extinction within a comparatively short period. The diminution in question is not only in number but in size, it being, of course, quite natural that the larger ones should be more closely pursued. A principal cause of this decrease has been the enormous consumption by canning factories, where many millions of pounds are annually put up for exportation to all parts of the world. It is perhaps quite safe to say that within twenty years the decrease all along the coast has amounted from 50 to 75 per cent.

The question of the artificial production of the lobster is one that is beset by many difficulties, especially in view of the fact that the eggs are fertilized within the body of the female, and subsequently attached by a small, short pedicel to the hairs of her legs, where they are kept in constant motion. Artificial impregnation is therefore out of the question, and in what way the eggs can be best developed, whether in connection with the parent or removed and reared in hatching jars, is yet to be settled. Experiments are, however, in progress in this connection, and the results will be published hereafter.

The bulletins of the Fish Commission contain numerous articles on this subject, and in the forthcoming quarto series an elaborate paper by Mr. Rathbun will be found upon the past and present distribution, statistics, &c., of this animal. Something may be done in the way of multiplication of the species by transplantation, and an experiment has lately been tried by the Commissioner in this direction. On August 24 of the present year one hundred live lobsters, partly with eggs, were obtained through the assistance of Mr. E. G. Blackford, of New York, and transported on the Fish Hawk from Fort Pond Bay, Long

Island, to the ripraps in Chesapeake Bay, with the loss of only two or three individuals. It is hoped that future reports may contain a further history of this experiment.

v. The Oyster (*Ostrea virginica*).

Experiments with the eggs and embryos of the common oyster (*Ostrea virginica*) were carried on for the season of 1882 at the experimental station on Saint Jerome Creek, Maryland, by Col. M. McDonald and J. A. Ryder, under the auspices of the U. S. Fish Commission. Other experiments were also conducted at Beaufort, N. C., by Francis Winslow, U. S. N., and Prof. W. K. Brooks, while Mr. Henry J. Rice made investigations in Mr. E. G. Blackford's laboratory, Fulton Market, New York City. Mr. Rice has since then published his results in *Forest and Stream* and in the thirteenth biennial report of the commissioners of fisheries of the State of New York. His laboratory experiments made upon a limited scale involved the use of two vessels; one as a supply reservoir for the water used in the incubation of the eggs, and another vessel used as a receptacle in which the young oysters were successfully confined. Bands of flannel were used as capillary conductors of the water from the supply reservoir to the hatching-box, and a similar band was used to carry the water from the latter into an outside reservoir. By means of such an apparatus the experimenter was enabled to keep the young oysters, placed in the vessel, alive for fourteen days. Certain improvements in this apparatus made afterwards have rendered it more perfectly adapted to the purpose for which it is designed, that is, the outlet pipe has been so arranged as to prevent the escape of the whole of the water from the hatching-box, and in such a way as to make the method available in the construction of large ponds for the artificial rearing of the oyster.

Mr. Ryder left Washington with the U. S. Fish Commission steamer *Fish Hawk* in June, 1882, but did not begin any actual experiment until July 3 following. In the course of his investigations in 1882, in co-operation with Colonel McDonald, it was found to be possible to carry young oysters, which had been reared from artificially fertilized eggs to the condition of fixation, twenty-four hours after fertilization, as he has already reported in a paper entitled "An account of experiments in oyster culture and observations relating thereto (second series)," and published in the report of the U. S. Commission of Fish and Fisheries for 1882. These experiments led to the attempts made in 1883, which have resulted in the demonstration of the fact that oyster spat can be reared from artificially impregnated eggs, as was shown experimentally at Stockton, Md., during last season on the premises of Messrs. Shepard and Pierce, these gentlemen generously bearing the expense of the construction of the pond in which the experiments were conducted under the supervision of Mr. Ryder.

The results of the Stockton experiments have been fully described in

an article by Mr. Ryder published in the Bulletin of the U. S. Fish Commission, vol. iii, 1883, pp. 281-294, and it has there been shown that in a pond $3\frac{1}{2}$ feet deep and covering an area of about 50 square yards, connected by a trench 10 feet long with Chincoteague Bay, it was possible to secure spat from artificially fertilized eggs, provided that the fertilized brood introduced into the inclosure was confined by means of a porous diaphragm of sand fixed into the trench, through which the tide could ebb and flow, so as at once to confine such brood and also exclude injurious enemies from entering the pond from the open waters.

Forty-six days after the beginning of this experiment oyster spat from one-fourth to three-fourths of an inch in diameter was found affixed to the shell collectors hung upon stakes in this inclosure. These results have led to the establishment of small breeding ponds at the oyster-cultural station of the U. S. Fish Commission at Saint Jerome Creek, Maryland, where further experiments in artificial breeding will be conducted during the season of 1884, the condition there being now such as to give every indication of the fact that we may reasonably expect to meet with the same success as was had at Stockton last year.

The set of spat during the season of 1883, as elsewhere mentioned, was unusually large, the season being apparently an exceptionally favorable one.

The work of the oyster commission of Maryland in revising the statutes regulating the oyster fishery of that State has also been an important step in testing the effects of restrictive legislation, and we may watch with no small degree of interest the results of the action of the Maryland oyster commission, the views of which have been enacted into statutes by the State legislature.

It may and very probably will be found possible to extend the northern system of deep-water oyster culture to the whole of the deep-water Chesapeake area, in the event of which the States of Virginia and Maryland should take joint action in framing a law or laws the object of which should be to protect and encourage those engaged in the industry. Systematic culture in the Chesapeake Bay can be made to produce great results, and place that region pre-eminently above all others combined as respects the annual yield of oysters.

The year 1883 has also been an unusually noteworthy one in respect to the number of persons who have, as specialists or experts, contributed to our knowledge and life history of the oyster. In the front rank among these must be mentioned Prof. Thomas H. Huxley, who gave an address before the Royal Institution of London, May 11, 1883, which was afterwards published in the English Illustrated Magazine, for October and November, 1883, in which he gives a remarkably clear and readable account of the life history of the European oyster (*Ostrea edulis*), and with characteristic clear-sightedness gives expression to his views as to what is to be done about the oyster question.

The Dutch zoological commission has also been active, and prob-

ably the most noteworthy contribution to the literature of the anatomy of *O. edulis* which has appeared in Europe for thirty years past is a paper entitled "De Voortplantingsorganen van de Oester, Bijdrage tot de kennis van hun bouw en functie," by Dr. P. P. C. Hoek, and illustrated by six well-executed lithographic plates. This paper, published in the *Journal de la Société Néerlandaise de Zoologie* (Liv. I, 1883), gives for the first time a fully illustrated description in Dutch and French of the organs of Bojanus of *O. edulis*.

The same paper also contains the most complete bibliography extant of works relating to the oyster and oyster culture, which may be consulted by those interested, with the assurance that about all that has been written upon the subject up to within the last two or three years has been noticed.

Professor Horst, of the Dutch commission, has also made some important investigations upon the early stages of development of *Ostrea edulis*, in which he has indicated the true nature of the gastrula stage of this mollusk and the mode in which the supraesophagal ganglion is developed.

During the same period the French naturalists have also been very active, notably G. Bouchon-Brandley and Adrien Certes. The former of these was the first to introduce a successful method of rearing the spat of the dioecious *O. angulata* from artificially impregnated eggs at Verdon, in inclosed ponds, in 1882, though constant daily tidal action was not permitted to effect the change of the water in the ponds as in the American experiments with the eggs of *O. virginica* instituted by Mr. Ryder.

American investigators have been no less active than their foreign brethren. Prof. W. K. Brooks and Lieutenant Winslow—the first as the biological editor of the report of the oyster commission of the State of Maryland, and the latter in his elaborate investigations upon the distribution, area, and condition of the oyster beds of the Eastern United States—have contributed much valuable information upon the subject of the oyster industry of America.

Dr. W. M. Hudson and Hon. Robert G. Pike also deserve particular mention here in connection with their effective efforts in improving the condition of the oyster beds under the jurisdiction of the State of Connecticut.

Mr. J. A. Ryder, of the U. S. Fish Commission, has also been active in contributing towards a knowledge of the life-history of the American oyster. His experiments and investigations have covered a large range of work upon the anatomy, histology, and physiology of the animal. Among the most important of his researches are as follows: Those which have determined the true nature of the "greening of oysters," the absorption of phycocyanin from the diatoms swallowed as food, and its retention by the colorless blood corpuscles of the animal; the structure of the gills, circulatory system, and reproductive and excre-

tory organs; the discovery that the reproductive organs might be almost or altogether atrophied at the end of the spawning season; the elucidation of the effects of osmose and its influence in affecting the bulk and appearance of the flesh of the oyster so as to improve or injure its appearance for the markets, when immersed for a short time in less dense or denser water than that from which the animal was first taken; the true nature of the so-called fattening process, the kinds and distribution of the food of the oyster as well as its messmates and parasites.

Besides the minor papers which Mr. Ryder has issued during the past year upon the subject of oysters and oyster culture he has had prepared under his direction "A Sketch of the Life-History of the Oyster" for the annual report of the geological survey of the Territories for 1883, besides a paper entitled "A Contribution to the Life-History of the Oyster" for the forthcoming quarto fishery report of the U. S. Census. In both of these papers the author has very fully illustrated the anatomy and development of the American oyster with carefully drawn figures.

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

26.—CLASSIFICATION OF ARTICLES.

In the general Appendix to this report will be found a series of forty separate papers treating upon matters relating to the work of the Fish Commission. These are classified under six headings, as follows:

A.—GENERAL.

The first paper is by Lieut.-Commander Z. L. Tanner, and gives a full account of the construction and outfit of the steamer Albatross, illustrated by a number of figures and more than fifty plates. It is followed by his report on the work done by the steamer during the year 1883. In this he has included the subordinate reports of Capt. Jacob Almy, Ensign R. H. Miner, Passed Asst. Surg. C. G. Herndon, Lieut. Seaton Schroeder, and various tables of temperatures, specific gravities, speed of trawlings and soundings, stations occupied, &c. A paper by Livingston Stone is entitled "Explorations on the Columbia River, from the head of Clarke's Fork to the Pacific Ocean, made in the summer of 1883, with reference to the selection of a suitable place for establishing a salmon-breeding station." This is followed by a reprint of the British sea-fisheries act of 1883.

B.—THE FISHERIES.

In this section are found ten papers, the first giving a tabulated estimate of the catch of fish of the principal rivers of the United States in 1880. This was prepared by Mr. Smiley from material collected during the work on the Tenth Census, and shows a total of 184,783,050 pounds.

The same author presents the statistics of the United States imports and exports of fishery products for the current year. These are based upon information furnished by the Bureau of Statistics. A paper on the fisheries of Great Britain and the Fisheries Exhibition of 1883, by R. W. Duff, M. P., is presented in abstract as somewhat explanatory of the great International Fisheries Exhibition. Of the two papers relating to the whale fisheries, the first is a statistical review of the past two years, compiled by Mr. Smiley, and the second a translation from the German of a description of Svend Foyn's whaling establishment. A translation from the Swedish of Prof. A. V. Ljungman upon the great herring-fisheries is of interest. It is followed by two papers from the Danish upon the Norwegian fisheries of 1883, and the Iceland cod-fisheries of 1883. A paper upon the fisheries of India by Francis Day, formerly inspector-general of fisheries in India, gives a very comprehensive view of that industry. The last paper is by Rudolph Lundberg, upon the Swedish eel-fisheries and the apparatus used therein.

C.—ECONOMIC RESEARCH.

Prof. W. O. Atwater has presented herein his second contribution to our knowledge of the chemical composition and nutritive values of American food-fishes and invertebrates, a former paper on the same subject having been furnished by him for the Report of 1880.

D.—NATURAL HISTORY AND BIOLOGICAL RESEARCH.

Of the six papers in this section the first two relate to the explorations made by the Commission along the Gulf Stream, Professor Verrill presenting the general results of the Albatross explorations in 1883, and Miss Bush giving a list of the deep-water mollusca dredged by the Fish Hawk in 1880, 1881, and 1882. In a paper by A. V. Ljungman, translated from the Swedish, will be found some valuable notes upon the natural history of the herring and the management of the herring fisheries during the past ten years. A paper by R. W. Shelfeldt, M. D., upon the osteology of *Amia calva* is illustrated by fourteen plates; and one by Gustav Eisen, entitled "Oligochætological Researches," is illustrated by ten plates. The last paper is by William P. Seal, upon the aqua-vivaria as an aid to biological research, and is illustrated by three plates.

E.—PROPAGATION OF FOOD-FISHES.

The sixteen papers in this section relate mostly to the propagating operations of the Fish Commission, and consist of reports from the persons charged with the work of propagation or distribution. These are upon the fish eggs sent to foreign countries, by Mr. Mather; the operations at Northville and Alpena Stations, by Mr. Clark; the salmon and trout-breeding work on the McCloud River, by Mr. Stone; the Penobscot and Schoodic salmon work in Maine, by Mr. Atkins; the

miscellaneous work at the Central Station, by Mr. McDonald; the shad-hatching operations at Fort Washington, by Lieutenant Babcock; the shad-hatching at Havre de Grace, by Lieutenant Lowe; the experiments in penning shad, by Mr. Clark; the general work of distribution, by Mr. McDonald; and the hatching of Spanish mackerel, by Lieutenant Wood and by Dr. Kite. There are also included three papers upon carp culture, which have been considered worthy of translation from the German, the first by Prof. B. Benecke, the second by Max von dem Borne, and the third by Adolph Gasch.

F.—MISCELLANEOUS.

In this section will be found a short account of the laying out of oyster ponds at Saint Jerome, by Lieutenant Wood; suggestions to keepers of life-saving stations and others, relative to the best means of collecting and preserving specimens of whales and porpoises, by F. W. True; and a compilation of statements concerning the fisheries of several different countries, as reported by the United States consuls abroad to the United States Department of State.

This series of forty papers contains many that are considered of very high value, and is illustrated by more than one hundred and fifty plates. Ten of the longest papers are provided with special indexes, as it is often desirable to issue these in separate pamphlet form for distribution to specialists not interested in the contents of the entire volume.

E.—SUPPLEMENT TO THE REPORT PROPER.

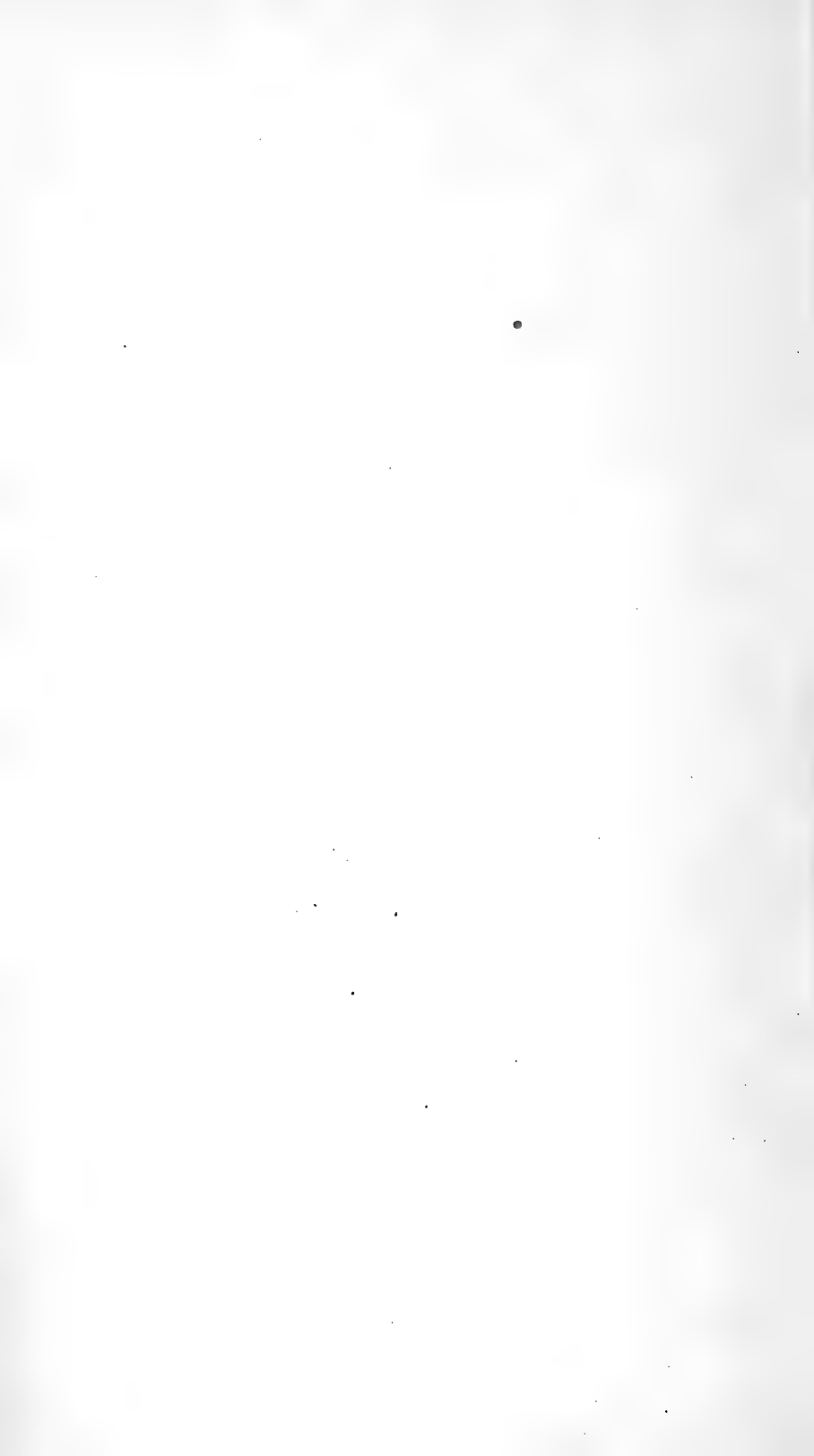
27.—LIST OF LIGHT-HOUSE KEEPERS RENDERING ASSISTANCE.

The following is a list of the light-houses (with their keepers) at which temperatures and occurrences of ocean fish have been observed during a portion or all of the present year:

List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year 1883, together with the number of monthly reports made at each one.

Petit Manan light-house, Petit Manan Island.	
George L. Upton, Millbridge, Me	12
Mount Desert light-house, Mount Desert Rock.	
Thomas Milan, Southwest Harbor, Me	12
Matinicus Rock light-house, Penobscot Bay.	
William G. Grant, Matinicus, Me	12
Seguin light-house, Seguin Island, Kennebec River.	
Thomas Day, Hunnewell's Point, Me	12
Boon Island light-house.	
Alfred J. Leavitt, box 808, Portsmouth, N. H.	12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay.	
Frank F. Martin, Cohasset, Mass	12
Race Point light-house, Cape Cod Bay.	
James Cashman, Provincetown, Mass	12
Pollock Rip light-station, entrance to Vineyard Sound.	
Joseph Allen, jr., South Yarmouth, Mass	12

Nantucket New South Shoal light-station, Davis New South Shoal.	
Andrew J. Sandsbury, Nantucket, Mass	12
Cross Rip light-station, Vineyard Sound.	
Luther Eldredge, Chatham, Mass	12
Buoy Depot, Government wharf, office inspector second division.	
Benjamin J. Edwards, Wood's Holl, Mass	12
Vineyard Sound light-station, Sow and Pigs Rocks.	
William H. Doane, 13 Kempton street, New Bedford, Mass.	12
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor.	
Charles D. Marsh, Newport, R. I	12
Block Island light-house, southeast end of Block Island.	
H. W. Clark, Block Island, R. I.	12
Bartlett's Reef light-station, Long Island Sound.	
Daniel G. Tinker, New London, Conn	12
Stratford Shoals light-house, Middle Ground, Long Island Sound.	
James G. Scott, Port Jefferson, N. Y	12
Fire Island light-house, south side of Long Island.	
Seth R. Hubbard, Bay Shore, N. Y.	12
Sandy Hook light-house, entrance to New York Bay.	
James Cosgrove, 128 Rutledge street, Brooklyn, N. Y. (succeeded by A. H.	
Pritchard, 120 Spencer street, Brooklyn, E. D., N. Y., in April)	12
Absecon light-house, Absecon Inlet.	
A. G. Wolfe, Atlantic City, N. J	12
Five-Fathom Bank light-station, off Delaware Bay.	
William W. Smith, Cape May City, N. J.	12
Fourteen-Foot Bank light-station, Delaware Bay.	
Ed. A. Howell, Delaware City, Del. (succeeded by John Lund, Wilmington,	
Del., in October)	12
Winter-Quarter Shoal light-station, Chincoteague Island.	
C. Lindemann, 857 Broadway, Brooklyn, E. D., N. Y.	12
York Spit light-house.	
James K. Hudgins, Port Haywood, Va.	9
Wolf Trap Bar, Chesapeake Bay, Virginia.	
John L. Burroughs, New Point, Matthews County, Va.	12
Stingray Point light-house.	
C. S. Lankford, Sandy Bottom, Va. (succeeded by Charles F. Sadler, Hudgins,	
Va., in April)	12
Windmill Point, mouth of Rappahannock River.	
James G. Williams, Hookumfair, Va.	12
Body's Island light-house, north of Cape Hatteras.	
Peter G. Gallop, Manteo, Dare County, N. C.	12
Cape Lookout light-house, Cape Lookout.	
Deward Rumley, Beaufort, N. C.	12
Frying-Pan Shoal light-station, Cape Fear.	
John D. Davis, Smithville, N. C.	12
Rattlesnake Shoal light-station, off Charleston.	
John McCormick, Charleston, S. C.	12
Martin's Industry light-station, Port Royal Entrance.	
John Masson, Port Royal, S. C.	12
Fowey Rocks light-house, Fowey Rocks.	
John J. Larner, Miami, Fla	12
Carysfort Reef light-house, Florida Reefs.	
F. A. Brost, Key West, Fla	11
Dry Tortugas light-house, Loggerhead Key.	
Robert H. Thompson, Key West, Fla.	12



APPENDIX A.

GENERAL.





U. S. Fish Commission steamer Albatross.

I.—REPORT ON THE CONSTRUCTION AND OUTFIT OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS.

BY LIEUTENANT-COMMANDER Z. L. TANNER, U. S. N.

CONTENTS.

- A.—Preface by the Commissioner.
- B.—Construction of the Albatross.
- C.—Steam machinery and mechanical appliances. By Engineer Baird.
- D.—Apparatus for deep-sea research.
- E.—General description of methods of sounding, &c.
- F.—Other apparatus.
- G.—Co-operation of the Navy Department.

A.—PREFACE BY THE COMMISSIONER.

The alleged decrease of the food-fishes along the sea-coasts and in the lakes of the United States induced the passage by Congress, in 1871, of an act authorizing the appointment by the President, with confirmation by the Senate, of a Commissioner of Fish and Fisheries to investigate the subject and report the facts as ascertained, with any recommendations that might seem desirable; and Prof. Spencer F. Baird, the then Assistant Secretary of the Smithsonian Institution, received the appointment.

The investigations in question were at first restricted to the examination of the inshore waters; but the many questions arising in regard to the movements of the mackerel, the bluefish, the menhaden, and other pelagic species, caused the Commissioner to make application to Congress for means to build a sea-going steamer, by the aid of which the movements of the sea fish could be more readily followed, and their lines of migration and winter habitat determined. An appropriation of \$103,000 was accordingly made in 1881 for building such a vessel, which was, however, found insufficient to construct a steamer upon the approved plans of Mr. Charles W. Copeland, of New York. An additional sum having been allowed by Congress, making an aggregate of \$145,000, proposals were invited, and Messrs. Pusey & Jones, of Wilmington, Del., being the lowest bidders, and their offer coming within the amount of the appropriation, work was commenced by that firm in March, 1882, and the trial trip was made December 30, 1882.

Some repairs and alterations made it necessary to send the steamer back to the ship-yard of the builders; and in April, 1883, the vessel made her first cruise on the business of the Commission.

Lieut. (now Lieutenant-Commander) Z. L. Tanner was ordered by the Navy Department to superintend the construction of the vessel. He made many important suggestions, and his practical experience was of the utmost benefit in the final determination of the plan of construction. The equipment of the vessel was entirely under his direction, and to his ingenuity is due a large number of the novel and important devices and improvements adopted.

SPENCER F. BAIRD,
Commissioner.

B.—CONSTRUCTION OF THE ALBATROSS.

The United States Fish Commission steamer Albatross is an iron twin-screw vessel, built by the Pusey and Jones Company, of Wilmington, Del. She was launched August 19, 1882 (see frontispiece).

Her general dimensions are as follows:

Length over all, 234 feet.
Length at 12-foot water-line, 200 feet.
Breadth of beam, moulded, 27 feet 6 inches.
Depth from top of floor to top of deck beams, 16 feet 9 inches.
Sheer forward, 5 feet 2 inches.
Sheer aft, 3 feet.
Height of deck-house amidships, 7 feet 3 inches.
Displacement on 12-foot water-line, 1,074 tons.
Registered tonnage (net), 384 tons.

ANCHORS AND CHAINS.

One 1,900 pounds, 120 fathoms, $1\frac{3}{8}$ -inch chain.
One 1,288 pounds, 120 fathoms, $1\frac{3}{16}$ -inch chain.
One 1,030 pounds.
One 600 pounds, 250 fathoms. Bullivant's.
Elastic steel wire cable, $3\frac{1}{2}$ inches diameter.

She is rigged as a brigantine, carrying sail to a foretop-gallant sail. The spars are of white pine and spruce, and the following are their dimensions, viz:

SPARS.

Name.	Feet.	Diameter in inches.
Mainmast above main deck	56	20
Maintop-mast above cap	32	9 $\frac{1}{2}$
Foremast above deck	52	21
Foretop-mast above cap	30	10 $\frac{1}{2}$
Fore yard, length	50	11
Foretop-sail yard, length	40	9
Foretop-gallant yard, length	27 $\frac{1}{2}$	5 $\frac{1}{2}$
Fore gaff	27	7 $\frac{1}{2}$
Main boom	56	12 $\frac{1}{2}$
Main gaff	36	9 $\frac{1}{2}$
Dredging boom	36	10

Bowsprit, 13 inches square, 10 feet outboard to shoulder. Round-top on foremast. Cross-trees on mainmast.

SAILS.

Name.	Canvas.	Square feet.
Mainsail	No. 2	1,488
Gaff-topsail	No. 7	578
Foresail (27-foot drop)	No. 2	1,156
Fore trysail	No. 2	872
Foretop-sail (24½-foot hoist)	No. 4	934
Foretop-gallant sail (14½-foot hoist)	No. 6	389
Fore staysail	No. 2	660
Jib	No. 5	918
Flying jib	No. 6	526
Total sail area		7,521

Index to the detailed plans of the steamer Albatross.

No.	Articles.	No.	Articles.
	POOP-HOUSE AND FORECASTLE DECKS (PLATE II).		MAIN DECK—continued.
1	Forecastle.	54	Washstand.
2	Wooden bitts.	55	Chronometer chest and lounge.
3	Fish-davit.	56	Berth.
4	Capstan (connected with steam windlass).	57	Bunker-plate and coal-chute.
5	3-inch rifled howitzer.	58	Upper laboratory.
6	Sigsbee deep-sea sounding machine.	59	Hatch to lower laboratory.
7	Top of pilot-house.	60	Work-table for naturalists.
8	Top of deck-house.	61	Dispensary case.
9	Bridge.	62	Bookcase.
10	Skylight over chart-room and laboratory.	63	Sink.
11	Whale-boat.	64	Steam-heater.
12	Seine-boat.	65	Naturalists' state-rooms.
13	Standard compass.	66	Berth.
14	Smoke-stack.	67	Washstand.
15	Ventilator to fire-room.	68	Bureau.
16	Skylight over drum-room and galley.	69	Steam-drum.
17	Steam-gig (Herreshoff).	70	Ash-chute.
18	Steam-cutter (Herreshoff).	71	Ventilators for fire-room.
19	Engine-room skylight.	72	Iron grating.
20	Dinghy.	73	Galley.
21	After compass.	74	Dresser.
22	Mainmast.	75	Baird's distiller.
23	Main boom.	76	Upper engine-room.
24	Bridge from top of poop to top of deck-house.	77	Iron bitts.
25	Poop-deck.	78	Wardroom companion-way.
26	Cabin skylight.	79	Wardroom skylight.
27	Iron bitts.	80	Commanding officer's cabin.
28	Screw steering-gear.	81	Cabin pantry.
	MAIN DECK.	82	Commanding officer's office.
29	Paint locker.	83	State-room.
30	Chain cables.	84	Berth.
31	Stopper for chain cables.	85	Bureau.
32	Compressor for steel-wire hawser.	86	Washstand.
33	Steam windlass.	87	Lounge.
34	Forecastle pump.	88	Sideboard.
35	Lamp room.	89	Table.
36	Bath-room for steerage officers.	90	Steam-heater.
37	Water-closets.	91	Bath-room.
38	Iron bitts.	92	Rudder-head.
39	Fore hatch.	93	Water-tank.
40	Hoisting engine.	94	Silver-closet.
41	Dredging boom.	95	Linen-closet.
42	Dredge-rope rove for use.		BERTH DECK.
43	Tanner sounding-machine.	96	Yeoman's store-room.
44	Foremast.	97	Fore passage.
45	Ship's bell.	98	Dredging store-room.
46	Pilot-house.	99	Brig.
47	Steam or hand steering gear.	100	Chain-pipes leading to chain-lockers.
48	Binnacle.	101	Collision bulkhead.
49	Signal-locker.	102	Hatch to ice-box.
50	Deck-lights.	103	Air-port.
51	Chart-room.	104	Bag-rack.
52	Steam-heater.	105	Hatch to forehold.
53	Chart-table.	106	Steam-heater.
		107	Reeling-engine.
		108	Governor pulley.

Index to the detailed plans of the steamer Albatross—Continued.

No.	Articles.	No.	Articles.
BERTH DECK—continued.		BERTH DECK—continued.	
109	Steerage.	145	Ventilating-pipe.
110	Steerage-rooms.	146	Quadrant of rudder.
111	Berth.		HOLDS.
112	Bureau.	147	Magazine.
113	Washstand.	148	Magazine-passag.
114	Table.	149	Fore-peak.
115	Open pantry.	150	Ventilating pipe with branches.
116	Water tight iron bulkhead.	151	Keelson.
117	Lower laboratory.	152	Keel.
118	Lockers for specimen bottles.	153	Chain-lockers.
119	Steam-heater.	154	Collision bulkhead.
120	Sink.	155	Ice-box.
121	Table.	156	Cold-room.
122	Photographer's dark-room.	157	Upper hold.
123	Coal-chutes.	158	Lower hold.
124	Air-ports.	159	Steel wire hawser-reel.
125	Coal-bunkers.	160	Store-rooms.
126	Boilers.	161	Fresh-water tanks.
127	Exhaust-fan for ventilating the vessel.	162	Water-tight iron bulkheads.
128	Iron grating.	163	Laboratory store-room.
129	Main engines.	164	Ballast-room and sinkers.
130	Dynamo-machine (Edison).	165	Water-tight iron bulkhead.
131	Wardroom companion-ladder.	167	Boiler leg.
132	Wardroom pantry.	168	Fire-room.
133	State-room.	169	Lower engine-room.
134	Bureau.	170	Water-tight iron bulkhead.
135	Washstand.	171	Wardroom store-room and shaft-alleys.
136	Berth.	172	Water-tight iron bulkhead.
137	Wardroom.	173	Paymaster's store-room.
138	Table.	174	Equipment store-room.
139	Steam-heater.	175	Propeller-shaft.
140	Lounge.	176	A-frames for propeller-shaft.
141	Iron water-tight deck.	177	Propeller.
142	Bath-room.	178	Rudder.
143	Cabin store-room.	179	Rudder-chains.
144	Quadrant-room.		

HULL.

The Albatross has a "bar" keel of the best hammered iron, 8 by $2\frac{1}{4}$ inches, scarfs 25 inches in length. There is one bilge keel on each side $10\frac{1}{2}$ feet from the center line, parallel thereto, of two angle-irons 4 by 6 by $\frac{5}{8}$ inches, with a $\frac{7}{8}$ inch iron plate 16 inches deep riveted between, 80 feet in length, tapering in depth to nothing at each end.

The stern-post is of the best hammered iron, $7\frac{1}{2}$ by $2\frac{1}{2}$ inches; and the stern is of the same material, $7\frac{1}{2}$ by $2\frac{1}{4}$ inches.

The frames are of angle-iron; those under the engines and boilers 4 by 3 by $\frac{7}{16}$ inches; forward and aft of these they are $3\frac{1}{2}$ by 3 by $\frac{7}{16}$ inches. Frames and floor spaces, 21-inch centers.

The floors are in one piece 18 inches deep and $\frac{8}{16}$ inch thick for three-fifths the vessel's length amidships, $\frac{7}{16}$ inch thick forward and aft. They are on every frame extending 20 inches above the top of the floor amidships, molding to the size of the frames.

One limber-hole is cut on each side of the center keelson. Enlarged floors with necessary angle-irons and strengthening plates are provided for the foundations of the engines and boilers.

REVERSE BARS.

The reverse bars are of angle-iron, 3 by 3 by $\frac{5}{16}$ inches, one on every frame extending to the stringer plate and 12 inches above the upper turn of the bilge alternately. There are double reverse bars on all frames under the engines and boilers, and also on the line of all keelsons, hold stringers, and bulkheads. Joints are covered with angle-iron butt-straps, not less than 18 inches in length, with three rivets in each end.

KEELSONS.

On top of the reverse bars there is a center keelson, 12 by $4\frac{1}{2}$ inches, beam iron, $\frac{5}{8}$ inch thick for three-fifths the length amidships, and $\frac{4}{5}$ inch thick forward and aft. On each side, 8 feet 8 inches from the center line, there is a keelson of two channel bars, $7\frac{1}{2}$ by $2\frac{1}{2}$ by $\frac{5}{16}$ inches, riveted back to back; and at the bilge on each side a keelson of two angle-irons, 6 by $3\frac{1}{2}$ by $\frac{7}{16}$ inches, riveted back to back. The bilge keelsons conform to the shape of the floors, and the side keelsons run parallel to the center line. There is also a cross keelson for the shaft stuffing-boxes.

At a distance of 4 feet 7 inches from the center line on each side there runs a keelson of beam iron, 8 by $4\frac{1}{2}$ by $\frac{5}{8}$ inches, riveted to the reverse bars.

INTERCOSTAL KEELSONS.

Of these there is one of $\frac{5}{16}$ inch plate run on the center line, and one of $\frac{5}{16}$ inch plate under each side keelson, extending from keel to top of floors, well fitted between floors, and connected with them by an angle-iron $2\frac{1}{2}$ by $2\frac{1}{2}$ by $6\frac{5}{16}$ inches.

DECK BEAMS.

Additional intercostal keelsons are placed under the engines.

For the main deck they are of T bulb-iron, on alternate frames, 7 by $3\frac{3}{4}$ by $\frac{7}{16}$ inches for three-fifths the vessel's length amidships; forward and aft they are 6 by $3\frac{3}{4}$ by $\frac{3}{8}$ inches, except at the capstan and riding-bitts forward, and at hatches, where they are 8 by $\frac{7}{16}$ inches.

STRINGERS.

The main-deck stringers on each side are 38 inches wide by $\frac{4}{5}$ inch in thickness at midlength, reduced to 26 inches width at the end. Stringers are connected with sheer-strake by angle-irons, $4\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{7}{16}$ inches, securely riveted to both the deck beams and sheer-strake. At the foremast and mainmast there is riveted to the deck beams a stringer plate 42 inches wide and $\frac{3}{8}$ inch thick, long enough to cover two beams forward and aft of the mast, securely riveted to the deck beams; through this plate a hole for the mast is cut. Similar tie-plates, covering three or four beams, are riveted in wake of bitts, windlass, capstan, hoisting engine, and reeling engine.

TIES OF MAIN DECK

are run fore and aft from end to end each side of center line, at such distance from it as to clear all hatches. They are of plate iron, 15 by $\frac{1}{2}$ inches, securely riveted to deck beams and to stringer plates or breast hooks at the end; butts closely fitted and butt-straps double riveted. The width of these plates is gradually reduced to 9 inches forward and aft.

HOLD STRINGERS

are 24 inches wide by $\frac{1}{2}$ inch thick at midlength, gradually reduced to 18 inches in width at the ends, and are run fore and aft on frames at a height of 10 feet above top of floors, connected to deck beams and reverse bars by angle-irons. Alongside of the engines and boilers, where there are no hold-beams, these angle-irons are doubled back to back and riveted through.

BEAMS OF BERTH DECK.

Forward and aft of engines and boilers, and between them, there are hold-beams of channel-iron, 6 by $2\frac{1}{8}$ by $\frac{3}{8}$ inches, spaced to every alternate frame, connected and riveted to hold stringers and frames, and knued to frames the same as the main-deck beams.

IRON DECK-HOUSE.

The sides of the midship deck-house from the after end of the house to the bulkhead forward of the funnel, including these two bulkheads, are of plate iron, No. 5 wire gauge; stanchions, of 3 by 3 inches, angle-iron, spaced 24 inches from center to center. The beams are of angle-iron, 3 by 3 by $\frac{5}{16}$ inches, riveted to stanchion and to stringer and hatch-plate below.

PLATING.

The plating is run in fair lines, in and out strakes; all horizontal seams are lapped and all vertical seams, including bulwarks, are butted; spaces between outer strakes and frames are filled with liners of proper width and thickness.

The garboard-strake is $\frac{1}{16}$ inch thick for three-fifths its length amidships, gradually reduced to $\frac{8}{16}$ inch at the ends, and is 32 inches wide.

Sheer-strakes are fayed next to frames, $\frac{1}{16}$ inch thick for one-half the length amidships, gradually reduced to $\frac{8}{16}$ inch at the ends, and 38 inches wide. The upper edge extends $3\frac{1}{2}$ inches above top of plank-sheer to connect bulwark plates.

Bulwark plates from sheer-strake to rail are $\frac{5}{16}$ inch thick, well riveted to sheer-strake and frames. The whole length of the upper edge of the bulwark plates, on the outside, is run an angle-iron, $3\frac{1}{2}$ by $3\frac{1}{2}$ by $\frac{3}{8}$ inches, well riveted to bulwark plates, with proper lap-strips at the butts. To this angle-iron the rail is fastened.

The side-strake next below the sheer-strake is $\frac{4}{8}$ inch thick at mid-

ship length, gradually reduced to $\frac{7}{16}$ inch forward and aft. The remaining side plating is $\frac{9}{16}$ inch thick, except the strakes around the shaft-pipe, which are of $\frac{7}{16}$ inch and are doubled, and the bilge-strake, which is $\frac{9}{16}$ inch thick for two-thirds the length amidships, gradually reduced forward and aft to $\frac{7}{16}$ inch.

The bottom between bilge and garboard strakes is $\frac{4}{8}$ inch thick for three-fifths the length amidships, then gradually reduced to $\frac{7}{16}$ inch forward and aft.

All butts of plating, keelsons, and stringers are double chain riveted, and the longitudinal seams lapped and single riveted.

All plates are long enough to cover at least six frame spaces, except short plates at the ends; and there are at least two strakes between butts falling between same frames. All edges and butts are planed.

Butts of garboard-strakes are at least two frame spaces apart, as also are those of sheer-strakes and deck stringers. All butts of plating are properly shifted.

RAIL.

The rail is of white oak, $10\frac{1}{2}$ by $3\frac{1}{2}$ inches, let down to a fair bearing on the bulwark angle-iron, hook-scarfed and edge-bolted through scarfs.

MAIN DECK (PLATE II).

CABIN (PLATE III).

Of the structures which rise above the main rail the poop cabin extends 30 feet forward from the stern-post, is the whole width of the vessel, and 7 feet 3 inches high from deck to deck. It contains two state-rooms, an office, pantry, and bath-room, besides lockers, &c., and is supplied with light and air from eleven air-ports (five on each side and one in the stern), two windows, and three doors opening forward, and one skylight 6 feet by 5 feet overhead.

DECK-HOUSE.

Forward of the cabin there is a clear space of 16 feet containing the wardroom skylight, and from which the gangway ladders lead over the side. Next comes the deck-house, 83 feet in length, 13 feet 6 inches in width, and 7 feet 3 inches in height. It is built of iron from the funnel aft, sheathed inside and out with wood, and fitted with iron storm-doors. From the funnel forward it is of wood, all fastenings, nails, screws, &c., being of galvanized iron. Beginning aft it is divided into the following apartments:

1. ENTRANCE TO WARDROOM.

Six feet in length and the whole width of the house. One window on each side furnishes light and air, and two doors opening aft give access to the stairway leading to the wardroom below.

2. UPPER ENGINE-ROOM.

This is 10 feet 6 inches in length and the full width of the house. It has one door and one window on each side, a skylight 5 by 5 feet overhead, and a stairway leading to the engine-room below. The inside wooden doors of this room, as well as those of the kitchen and drum-room next forward, are fitted in halves, upper and lower, so that in bad weather the lower halves may be closed to keep out the water, while the upper are open for ventilation.

3. KITCHEN.

In length 8 feet, the whole width of the house, with one door and one window on each side, and a skylight 4 by 5 feet overhead. It is furnished with a table, fuel-boxes, lockers, dish-racks, and a lead-lined sink fitted with a pump, drawing water from the tanks in the hold.

4. DRUM-ROOM.

This is also the entrance to the fire-room, is 13 feet 6 inches in length, and the width of the house. It is fitted with doors and windows like those of the engine-room, has a skylight $4\frac{1}{2}$ by 5 feet overhead, and communicates by a stair-way with the fire-room below. As its name implies, this room contains the steam-drum, which is so designed that the funnel passes up through it, thus utilizing the heat of the escaping products of combustion to superheat the steam.

5. STATE-ROOMS.

Forward of the drum-room the wooden part of the deck-house commences with four state-rooms, two on each side, for the members of the scientific corps. Each room is 6 feet 6 inches in length, half the width of the house, and has a door and window with blind shutters, a berth 30 inches in width, a writing-desk, washstand, drawers, lockers, &c. Additional ventilation is secured by lattice-work openings, outboard, and also between the rooms.

6. UPPER LABORATORY (PLATE IV).

This is 14 feet in length and the whole width of the house. It is supplied with light and air by two windows and a door on each side and a skylight 6 by 3 feet overhead. In the center is a very conveniently arranged work-table, square in shape, around which four persons can seat themselves, each having at his right hand a tier of drawers which form the legs of the table. There are also two hinged side-tables, a sink with alcohol and water tanks attached, wall cases for books and apparatus, and in one corner a medical dispensary.

7. CHART-ROOM (PLATE V).

Immediately forward of the laboratory is the chart-room, 8 feet 6 inches in length, the full width of the house. It has one door and

window on each side and a skylight 3 by 3 feet above, drawers for charts, &c., a berth, washstand, lockers, book-shelves, and a transom sofa, which is also used as a chronometer chest. A door in the forward bulkhead gives access to the pilot-house.

8. PILOT-HOUSE (PLATE VI).

This is the next and last division of the deck-house. It is 8 feet in length, the full width of the house, and has one door on each side. The front is elliptical, with glass windows, balanced by weights, and protected in bad weather by strong wooden shutters hung in the same manner as the windows and fitted with 8-inch bull's-eyes in the center.

The pilot-house is raised about 3 feet above the main-deck and projects the same distance above the top of the house, with which it communicates by two windows. Suitable bell-pulls and speaking-tubes furnish the necessary means of communication with the engine-room, and instead of the ordinary ship's wheel a Higginson's steam quarter-master is used.

TOP-GALLANT FORECASTLE.

The top-gallant forecastle is 44 feet in length and 6 feet 3 inches in height between decks. On it are stowed the anchors, which are handled by a single fish-davit amidships and a capstan which can be worked by hand or by the steam-windlass (Plate XIV) directly underneath. On the port side aft is the Sigsbee deep-sea sounding machine, and just abaft the capstan is a 3-inch breech-loading rifle mounted on a boat carriage.

Underneath the forecastle are water-closets for officers and men, bath-room for men, lamp-room, paint-locker, steam-windlass, and carpenter's bench. Two scuttles give access, one to the store-rooms, magazine, &c., forward of the collision bulkhead, and the other to the berth deck.

BERTH DECK (PLATE VII).

This includes the space 40 feet aft from the collision bulkhead, and is 7 feet 10 inches between decks. It is supplied with light and air by the fore hatch, fore scuttle, and by eight 8-inch air-ports, four on each side. Racks for stowing bags and hammocks are fitted along the sides; the space abaft the fore hatch is occupied by the reeling-engine, and near the forward bulkhead are two scuttles opening into the ice-boxes.

ICE-BOXES.

These occupy the space 7 feet aft from the collision bulkhead the whole width of the ship. A strong fore and aft bulkhead amidships divides this space into two compartments; the sides and ends are fitted double with an intervening air-space of four inches which is filled with proper non-conducting material. The inside is lined throughout with

galvanized iron, and, at the after outboard corners, lead pipes with suitable traps drain the water into the hold. The capacity of the ice-boxes is about 3 tons each, 6 tons in all.

COLD-ROOM.

The after part of the space in the ice-boxes for two feet is partitioned off by an athwartship bulkhead to form a cold-room or refrigerator, to which access is gained by doors opening into the fore hold. Six-inch openings at the top and bottom of the cold-room communicate with the ice-lockers, and a circulation of air is induced as the warmer air of the former rising passes above into the latter, becomes cooled by the ice, falls and re-enters the cold-room by the lower opening, to become warmer again and rise as before.

Rack-shelves to hold whatever is desired are fitted against the bulkhead.

STORE-ROOMS, MAGAZINE, BRIG, ETC.

Forward of the berth deck, and separated from it by the collision bulkhead, is a fore and aft passage-way to which access is gained by a scuttle and stairs underneath the top-gallant forecastle.

This passage opens forward into the yeoman's store-room, to the right into the brig, lighted and ventilated by an 8-inch air-port, and to the left into the dredging store-room, similarly furnished with light and air.

Through this passage, also, the chain pipes pass down and aft, taking the chain from the windlass to the lockers below, and from the forward end of the passage a scuttle and stairs lead down to the magazine passage and magazine, and to the fore peak below them.

FORE HOLD.

Below the berth deck the space from the cold-room aft is taken up by the fore hold, steerage store-room, engineer's store-room, bread-room, sail-room, and water-tanks. Access is gained by a hatch directly under the fore hatch.

STEERAGE (PLATE VIII).

Opening from the after end of the berth deck is the steerage, containing four double-berth state-rooms, 6 feet 6 inches in length, two on each side, and a mess-room 13 feet in length between. It is lighted and ventilated by an 8-inch air-port in each room, a 12-inch ventilator cut through the deck just abaft the foremast, and the door opening from the berth deck. Each room has an upper and lower berth 30 inches wide, a bureau, washstand, toilet racks, drawers, shelves, &c. On the forward bulkhead of the mess-room is an open pantry.

LOWER LABORATORY (PLATES IX AND X).

Abaft the steerage, but separated from it by a water-tight iron bulkhead, is the lower laboratory immediately below the upper laboratory,

through which only can it be entered. This room extends quite across the ship, is 20 feet fore and aft, 7 feet 10 inches between decks, and is furnished with light and air by six 8-inch air-ports, two 12-inch deck-lights, and the hatch leading above.

Ample and convenient storage cases and lockers are provided for alcohol tanks, jars, and specimens in bottles of all sizes; long work-tables are fitted along each side; in one after corner is a lead-lined sink with running water; in the other a photographic dark-room; and along the bulkhead between the two is the chemical laboratory. Between the beams overhead are slings and hooks for stowing dip-nets, scoop-nets, harpoons, spears, lances, and other fishing appliances.

A hatch and stairs lead to the store-room below, a closed iron box capable of being isolated from the rest of the ship and filled with steam at short notice in case of fire. Here are stowed alcohol in tanks, nets, sieves, &c., for which suitables lockers have been provided.

Below this store-room is a small space next the skin of the ship where the sinkers used in sounding are stored.

WARDROOM (PLATE XI).

The whole space from the laboratories aft to the wardroom is occupied by the engines and boilers, bunkers, &c., and will be described in connection with them.

The wardroom is 38 feet in length, the full width of the ship, and 7 feet 10 inches in height from deck to deck. It is lighted and ventilated by seven 8-inch air-ports on each side, a skylight 6 by 5 feet overhead, and the stairway leading to the deck above.

The space on either side of the stairway is occupied by the pantry on one side, and the chief engineer's room on the other; the latter communicating by a door with the engine-room immediately forward. Aft these rooms a space 13 feet in length and the whole width of the ship is reserved for an athwartship extension-table, seating, at most, twelve persons. Along the sides of this space are fitted cushioned sofa transoms.

There are four rooms on each side, the starboard after one being furnished as a bath-room, the others containing a berth, bureau, washstand, drawers, lockers, &c. Two scuttles in the wardroom floor give access to store-rooms below; the paymaster's store-room forward, an iron water-tight compartment, and the equipment and navigator's store-room.

A scuttle in the pantry floor leads to the wardroom store-room, also a water-tight compartment. A door opens into a locker under the stairs.

The vessel is lighted throughout by electricity; and artificial ventilation is produced by means of an exhaust fan and conduit pipes to every compartment below the main deck.

BOATS.

The Albatross has five boats, as follows:

HERRESHOFF STEAM CUTTER.

The Herreshoff steam cutter is 26 feet 6 inches in length, 7 feet beam, and 3 feet 10 inches in depth, with double coil boiler and compound engine, cylinders 6 inches and $3\frac{1}{2}$ inches in diameter and 7-inch stroke, developing 16 horse-power with 100 pounds of steam. It has a keel condenser, and carries an average of 26 inches vacuum. The bunkers hold 1,100 pounds of coal, and the fresh-water tank, which is placed directly underneath the boiler, has a capacity of 42 gallons, sufficient for three days' steaming.

The hull and engine are of the best material and workmanship. Water-tight compartments at bow and stern have sufficient buoyancy to prevent sinking in case the boat is filled with water. Twelve persons can be seated comfortably in the stern sheets.

In addition to steam power, the boat is provided with sliding gunter masts and sails, schooner rigged, and makes good speed under sail alone. It is cutter build, with square stern, weighs 5,500 pounds, and has a speed of 8 knots.

STEAM GIG.

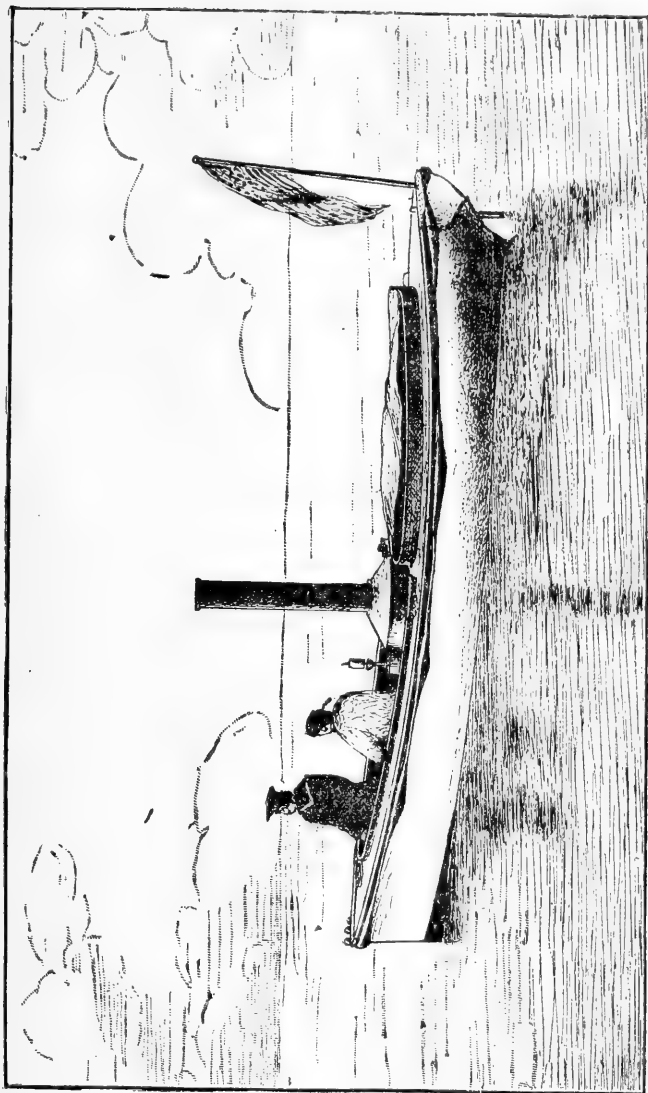
Built also by the Herreshoff Manufacturing Company. Twenty-five feet in length, 5 feet 2 inches beam, 3 feet $3\frac{1}{2}$ inches depth. A single coil boiler, compound engine, $4\frac{1}{4}$ inches and $2\frac{1}{2}$ inches diameter of cylinders, and 5-inch stroke, developing $7\frac{1}{2}$ horse-power with 100 pounds of steam.

It has the general form of a whale-boat, is double planked, spruce inside running diagonally, and mahogany outside running fore and aft. Both layers are bound together by brass screws at short intervals, making the structure unusually strong and light. There are water-tight compartments at bow and stern of sufficient capacity to float boat and crew in case it is filled with water. The total weight is 2,650 pounds.

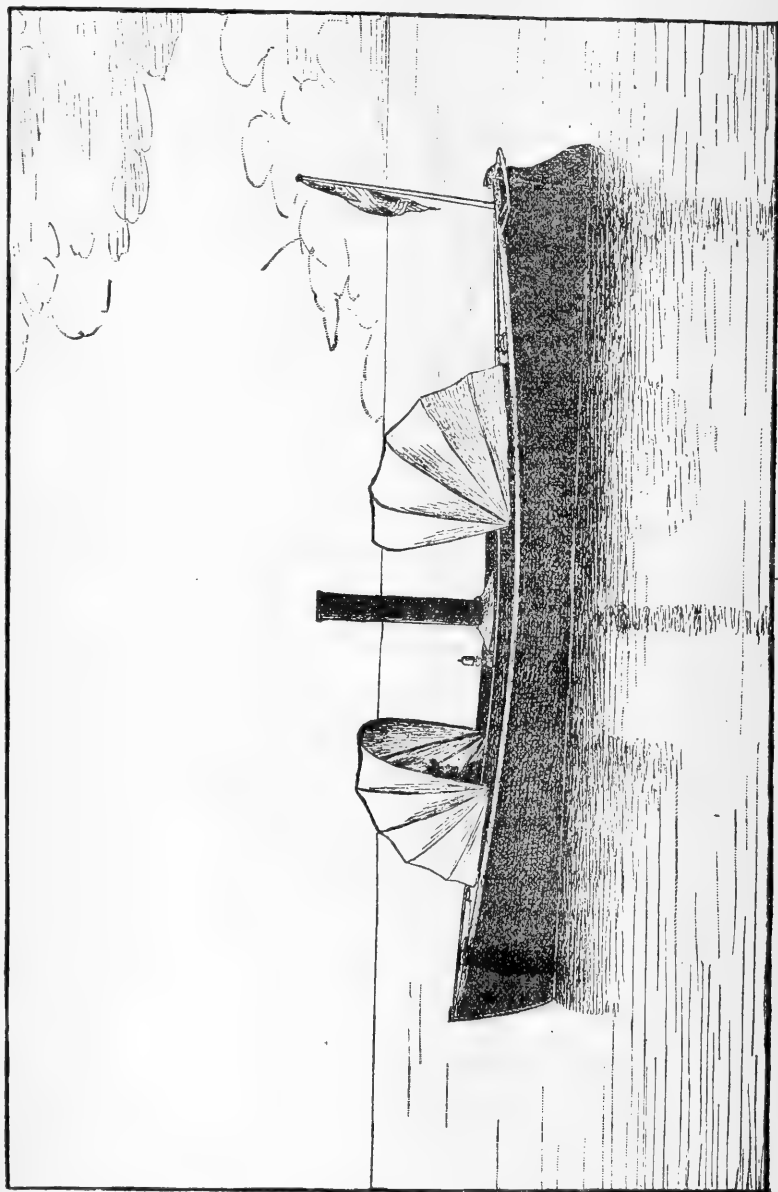
The bunkers hold 450 pounds of coal, and the fresh-water tank under the boiler carries 15 gallons, enough for two days' steaming. The ordinary speed of the boat is about 7 knots, although it can be driven to 8 for a short time. Seven persons can be seated comfortably in the stern sheets.

The location of the propeller under the bottom, about half the length from the stern, is a peculiar feature of this boat. It is so arranged that by a universal joint in the shaft the propeller can be hoisted and lowered, and when in the former position it does not project below the keel. When in use it is lowered, and no matter how heavy the sea, it is always submerged; thus racing is entirely avoided. The advantages of this system are not particularly apparent in smooth water, but her performance in a sea-way is remarkable. The gig is provided with a sliding gunter mast and sail, and makes good time under sail alone.

Steam can be raised in both cutter and gig in from three to five minutes.



HERRESHOFF STEAM CUTTER.



HERRESHOFF STEAM GIG.

SEINE-BOAT.

Built by Higgins & Gifford, Gloucester, Mass. Square stern, 28 feet in length, 7 feet 3 inches beam, 2 feet 6 inches in depth, and weighs 1,250 pounds. It pulls eight oars, and is schooner rigged, with sliding gunter masts. This boat is very light, and is designed especially for mackerel seining.

WHALE-BOAT.

Built at the navy-yard, Washington, D. C. Twenty-six feet in length, 5 feet 6 inches beam, 2 feet 3 inches depth. Pulls six oars, and weighs 780 pounds. Schooner rigged, with sliding gunter masts. This is an excellent boat, built with unusual care.

DINGHY.

Built at the Washington navy-yard. Eighteen feet 2 inches in length, 5 feet 6 inches beam, 2 feet 1 inch in depth, and pulls three pairs of sculls; weight, 550 pounds; rig, split lug-sail. The dinghy was also built with unusual care, and has done excellent service.

BOAT-DETACHING APPARATUS (PLATE XII).

The whale-boat and dinghy are kept hanging at the davits ready for emergencies, and are provided with a unique detaching apparatus, the invention of Midshipman (now Lieutenant) William Maxwell Wood, U. S. N.

The object of a detaching apparatus is to disengage both ends of a boat from the tackles at the same time, the operation being under the control of one man. To accomplish this Mr. Wood has provided a pair of links, L, Plate XII, Figs. 3 and 4, which oscillate freely about a center of motion. The form of this link is such as to permit the spherical toggle T to pass between its sides; now, if the link is pulled down by the chains rr' , and the ends of the chains connected by the slip hook h , the toggle will slide up in the link and be locked in the narrow space between its sides, as shown in full lines in Figs. 1, 3, and 4. If, however, the slip hook h is tripped by pulling the lanyard a , Figs. 1 and 2, both chains rr' will be slacked, and the links L released to fly up into the positions shown by the dotted lines in Fig. 1, releasing the toggles and thus detaching the boat.

The locks g are provided as a measure of safety to prevent the toggles from slipping out of the links in case one end of the boat is hoisted faster than the other, or a fall is accidentally let go; in fact they prevent either end from being detached until the links are released by pulling the lanyard a .

This simple apparatus has been in constant use, at sea and in port, under all conditions of wind and weather, and has answered its purpose admirably without a single failure or accident.

THE RUDDER AND STEERING GEAR.

The Albatross was designed to perform much of her work stern to wind and sea, making it necessary to give unusual attention to the rudder and its appointments. The several parts are much heavier and stronger than usual in vessels of her size, and the appliances for controlling its movements are more powerful than will be found in steamers of twice her tonnage.

RUDDER ATTACHMENTS.

There is a yoke, or quadrant, on the rudder-stock a little below the spar-deck beams, carrying the chains to which the steel wire tiller-ropes are connected; an iron tiller on the poop deck, and a yoke for a powerful screw steering-gear on the upper extremity of the stock, also on the poop deck. Projecting from the rudder is a short tiller to which are attached the rudder chains ordinarily carried by steamers.

HIGGINSON & CO.'S STEAM QUARTERMASTER.

This admirable steering gear is located in the pilot-house (Plate VI), and is operated either by hand or steam, the change from one to the other being effected in a few seconds without interfering with the control of the helm. The same wheel is used in either case, and a spoke has the same effect on the rudder in both cases. The fact that very little exertion is required when steam is used is the only indication the helmsman has that he is not steering by hand.

A chain passes over the chain-wheel, which is fitted to take the links, to prevent slipping, and the terminals of the chain are attached to the steel wire tiller-ropes which run aft under the spar-deck beams and connect with the chains on the yoke.

This apparatus is very compact, and has performed its work in a thoroughly satisfactory manner, without accident or cost for repairs. It was furnished by the Pusey and Jones Company, Wilmington, Del.

AUXILIARY STEERING-GEAR (PLATE XIII).

This powerful screw gear is used when it is necessary to put the vessel stern to a heavy sea, as in sounding and dredging, and is designed to hold the rudder rigidly, thus relieving the ordinary steering-gear from unusual strains. Fig. 1 is a longitudinal elevation, and Fig. 2 a plan view of the apparatus. The yoke *c* is keyed to the upper end of the rudder-stock *f*, and the arms *d*, which have a screw-thread at one extremity working on the right and left hand screw-shaft *i*, and a hole in the opposite extremity for the reception of the pins *a*, are the means of connection between the yoke *c*, the screw-shaft *i*, and the steering-wheel *l*.

The arms *d* are held in a horizontal position by the guide-rod *e*, which is supported by the adjustable bearings *k*, which also carry the screw-shaft.

To disconnect the gear, remove the pins *a* from the arms *d* and the slots *b*, when the rudder will move freely.

SPARE TILLER.

Fig. 1 shows the spare tiller *g* keyed to the rudder-stock *f*. The eyebolts *h* for the relieving tackles slide along the whole length of the tiller, for convenience in hooking in case of accident to the steering-gear.

RUDDER-CHAINS.

The rudder-chains are shackled to the short tiller projecting from the rudder, seized to an eyebolt in the stern, and carried along the quarters in the usual manner.

THE ALBATROSS DREDGING.

Plate I represents the Albatross in the operation of dredging at sea. The vessel is backing with her stern to the wind, as indicated by the forward trend of the dredge-rope, flags, &c. In prosecuting this work it is necessary to maneuver in such a manner that the drift will be from the dredge-rope, thus preventing it from drawing under the vessel's bottom. If steel wire rope is used for this purpose it will also be necessary to keep it under tension, for if allowed to slacken, even for a moment, it will kink, thus reducing its tensile strength about 50 per cent. Before putting the trawl or dredge over, then, we must decide in what direction it can be dragged to the best advantage. Working in a uniform depth of water this would naturally be toward the position in which the next haul was to be made; but when operating on a steep slope, such as will be encountered off our coast, an uphill drag is the only one offering a fair probability of success. If the wind is blowing in the direction of the down slope, we would turn the vessel's stern to it and back the engine, but if the breeze should be from the opposite direction this could not be done. We would then go ahead, keeping the wind more or less on the starboard side, from which the dredge is lowered. The range of direction is, of course, much greater under the latter conditions, as the vessel is under control of the helm.

Ocean currents serve to complicate in no small degree the work of deep-sea exploration. A surface set is quickly detected and guarded against or utilized in prosecuting the work; but when the rope is suddenly swept under the bottom by a submarine current, with perhaps thousands of fathoms of line out, it requires a great deal of tact and patience to clear it from the ship and land the trawl on the bottom without capsizing it or kinking the rope.

The Albatross is represented at work under the most favorable conditions, the trawl lowered from the starboard side, and the starboard engine backing slowly. This has the tendency to keep the wind a little on the starboard quarter, thus drifting the vessel away from the rope, which is seen to trend somewhat off the bow.

The greatest advantage to be derived from backing while dredging, is that in case the apparatus fouls on the bottom a stern-board can be checked and the strain on the dredge-rope relieved more quickly than when steaming ahead.

C.—STEAM MACHINERY AND MECHANICAL APPLIANCES.

By Passed Assistant Engineer G. W. BAIRD, U. S. N.

The designs and specifications of the motive engines, as well as the hull, were drawn by the distinguished engineer, Mr. C. W. Copeland, of New York, and they were built by the Pusey and Jones Company, of Wilmington, Del. There is a two-cylinder compound engine for each of the two propellers; the engines are independent, and are provided with steam reversing gears; they are upright but not vertical, the cylinders inclining towards each other (Plate XV) to give more room on the working-platform. There is one condenser, common to both engines, which is mounted on a bed-plate, and which forms the framing and cross-head guides for the engines; the single bed-plate supports the pillow-blocks of both engines. The condenser is of the type known as "surface condenser," and is arranged in three nests of horizontal tubes, the water passing successively through each nest, and the steam is condensed on the outside of the tubes.

There are two plunger air-pumps, placed horizontally, forward of the main engines, one plunger being worked from a concentric on the forward end of each crank-shaft. Both pumps are in one casting. The feed-pumps are worked from rods extending from the air-pump plungers.

The valves of the high-pressure cylinders are locomotive slides, over which gridiron cut-off valves are placed, while the low-pressure valves are double ported and are without cut-offs. All these valves are actuated by eccentrics and Stephenson links, in the usual manner.

The engines are provided with a system of valves by which they may be converted from compound to single expansion or simple engines.

There are two outboard deliveries, one for the circulating water and one for the air-pump or fresh water.

The circulating pump is a Davidson light-service pump, No. 26. (Plate XVII.)

There is a flexible coupling connecting each crank-shaft to its line-shaft, and the thrust-bearings are on the line-shafts.

The screw-propellers are right and left, with four blades each, the blades curving radially and axially, according to the style of the designer.

The shaft-brackets are of wrought iron; one is placed near the hub of the screw and the other half way between this and the hull. The journals of the bracket are lined with bronze and lignum-vitæ, and the shaft in these journals is covered by a bronze jacket in the usual way.

The stern pipes are of cast iron, the after floors bored to receive them, and the frames bent round them. The stern bearings are also of cast iron, with flanges fitting the hull; they are 3 feet 4 inches in length, lined with lignum-vitæ staves, and are recessed to receive the stern pipes; the usual stuffing-boxes are provided.

The sea-valves are of bronze with bronze stems, seats, and glands, with cast-iron chambers, and have outside threads.

The principal dimensions of the engines are as follow :

Number of cylinders to each engine	2
Diameter of the high-pressure cylinders .. inches ..	18
Diameter of the high-pressure piston-rods .. do ..	3
Net area of the high-pressure cylinders .. do ..	250.93
Clearance of the high-pressure piston .. do ..	.5
Length of the steam-port of the high-pressure cylinder .. do ..	13.5
Breadth of the steam-port of the high-pressure cylinder .. do ..	1.75
Area of the steam-port of the high-pressure cylinder .. do ..	23.625
Length of the exhaust-port of the high-pressure cylinder .. do ..	13.5
Breadth of the exhaust-port of the high-pressure cylinder .. do ..	3.5
Area of the exhaust-port of the high-pressure cylinder .. do ..	47.25
Number of ports in the cut-off valve ..	3
Length of the ports in the cut-off valve .. inches ..	13.5
Breadth of the ports in the cut-off valve .. do ..	.875
Aggregate area of the cut-off valve ports .. square inches ..	35.4375
Diameter of the low-pressure cylinders .. inches ..	34
Diameter of the low-pressure piston-rod .. do ..	3.5
Net area of each low-pressure cylinder .. do ..	903.11
Stroke of all the pistons .. do ..	30
Clearance of the low-pressure pistons .. do ..	.5
Length of the steam-ports of the low-pressure cylinders .. do ..	20
Breadth of the two steam-ports of the low-pressure cylinders .. do ..	3
Area of the double steam-port of the low-pressure cylinders .. do ..	60
Ratio of the volume of displacement of low-pressure piston to that of the high-pressure piston, per stroke ..	3.599
Length of pistons, on line of axis, at the circumference .. inches ..	6
Thickness of metal in all the cylinders .. do ..	1
Length of packing-rings on the high-pressure pistons .. do ..	4.5
Length of packing-rings on the low-pressure pistons .. do ..	3.75
Diameter of each (single-acting) air-pump plunger .. do ..	16
Stroke of air-pump plungers .. do ..	13.5
Displacement of each air-pump plunger per stroke .. cubic inches ..	2,814.84
Diameter of each feed-pump plunger .. inches ..	4.5
Stroke of each feed-pump plunger .. do ..	13.5
Displacement of each feed-pump plunger per stroke .. cubic inches ..	214.7
Diameter of the steam cylinder of the circulating-pump .. inches ..	14
Diameter of the steam piston-rod of the circulating-pump .. do ..	2
Net area of the steam piston of the circulating-pump .. cubic inches ..	152.3
Diameter of the water piston of the circulating-pump .. inches ..	16
Diameter of the water piston-rod of the circulating-pump .. do ..	2
Net area of the water piston of the circulating-pump .. square inches ..	199.49
Stroke of the pistons of the circulating-pump .. inches ..	14
Ratio of the area of steam piston to that of the water piston ..	1:1.308
Number of brass tubes in the condenser ..	2,394
Outside diameter of the condenser-tubes .. inch ..	.625
Exposed length of the condenser-tubes .. inches ..	66
Condensing surface of the tubes .. square feet ..	2,142
Number of crank-shaft journals to each engine ..	3
Diameter of the forward journal .. inches ..	7
Diameter of the middle journal .. do ..	8.5
Diameter of the after journal .. do ..	8.5
Length of the forward journal .. do ..	8.5
Length of the middle journal .. do ..	16
Length of the after journal .. do ..	13.5

	Ft.	In.
Diameter of the high-pressure crank-pins	5	$\frac{1}{2}$
Length of the high-pressure crank-pins	7	$\frac{1}{2}$
Diameter of the low-pressure crank-pins	7	$\frac{1}{4}$
Length of the low-pressure crank-pins	9	
Diameter of the high-pressure cross-head pins	3	
Length of the high-pressure cross-head pins	4	$\frac{1}{2}$
Diameter of the low-pressure cross-head pins	3	$\frac{1}{2}$
Length of the low-pressure cross-head pins	5	
Diameter of the line-shafts (wrought iron)	8	
Length in the vessel occupied by the engines	9	4
Breadth in the vessel occupied by the engines	15	6
Height of the engines above center line of shafts	12	6

The following is a list of the weights of the main engines :

CAST IRON.

	Pounds.
2 condenser covers	2,738
1 condenser	12,010
4 cylinders	14,820
1 bed-plate	15,412
2 "pinch-wheels" (couplings)	3,210
2 "crank-wheels" (couplings)	3,270
4 slide-valves	1,568
1 double air-pump and bed	2,750
4 steam-chests	2,520
4 steam-chest covers	2,084
10 eccentrics	1,188
4 pistons	1,586
4 line-shaft couplings	2,130
12 thrust-collars	2,260
4 cylinder-heads	2,509
2 stern-bearings	4,897
2 thrust-bearings	2,655
2 throttle-valve chambers	448
2 screw-propellers	8,076
2 stern-pipes	1,876

BRONZE CASTINGS.

4 tube sheets (condenser)	4,098
2 stern-bushings	257
2 shaft-bushings	663
2 air-pump plungers	1,030
6 link-blocks	101

PHOSPHOR-BRONZE CASTINGS.

6 lower boxes for crank-shaft	836
-------------------------------------	-----

IRON FORGINGS.

2 shafts	19,043
4 hangers	5,480
4 connecting-rods	2,266
4 straps, gibs, and keys	654
4 double-cranks	7,680
4 crank-pins	990
4 coupling-pins	764
6 valve-stems	590
5 links	786

	Pounds.
Air-pump connections	1,071
Levers and arms.....	731
Guides.....	843
12 eccentric rods	1,202
4 "cylinder braces" (struts)	1,104
Link connections	295
STEEL FORGINGS.	
4 piston-rods.....	1,877
BRASS TUBES.	
2,400 drawn-brass condenser-tubes	4,972
COPPER PIPE.	
Steam, feed, and blow pipes	3,458
REVERSING GEAR.	
2 steam cylinders, valves, guides, rods, arms, &c.	2,276
CIRCULATING-PUMP.	
1 Davidson light-service pump, No. 26.....	2,600
ADDITIONAL WEIGHTS.	
Floor-plates, flanges, cast-iron exhaust-pipes, bolts, nuts, &c., used in fitting up	48,017
No. 5 Davidson pump	1,100
No. 5 Davidson light-service pump	900
Total weight of motive engines	203,192

BOILERS.

There are two return-flue boilers (see Plate XVI) having a half steam drum and half chimney each; they are placed fore and aft in the hold of the vessel, side by side, with the fire-room athwartships and at the after end of the boilers. The axis of the chimney cuts the center plane of the ship, and is between the boilers. The two half chimneys are divided by a $\frac{3}{8}$ inch wrought-iron plate, riveted to both, so that the draught of one boiler is not affected by the other. Each boiler has its stop-valves, feed and blow valves, checks, whistle-valves, steam and water gauges, and damper complete. The boilers are covered with hair felting to retard radiation. The crown-sheets and flue sheets are of steel; all other portions of the boilers are of wrought iron. The flues are seamless, drawn, the flue sheets being flanged to receive them. The boilers are set in cast-iron chairs, and are provided with cast-iron ash-pans.

The principal dimensions of the boilers are as follow:

Number of boilers	2
Diameter of waist.....feet..	8 $\frac{1}{2}$
Length of boilers.....do..	21 $\frac{1}{4}$
Number of furnaces to each boiler	2
Width of furnaces.....inches..	43 $\frac{1}{2}$
Length of grate bars.....feet..	6 $\frac{1}{4}$
Aggregate area of grate surface in both boilers	95 $\frac{1}{4}$
Number of 15-inch flues in each boiler.....	2
Number of 12-inch flues in each boiler.....	2
Number of 11-inch flues in each boiler	6
Number of 9-inch flues in each boiler	16

Length of the 15, 12, and 11-inch flues	feet..	10
Length of the 9-inch flues	do..	16 $\frac{1}{2}$
Diameter of the complete chimney	inches..	52
Height of the chimney above the grates	feet..	46
Aggregate area, for draught, over the bridge-wall in both boilers, in square feet		18.16
Aggregate area through the lower flues of both boilers	square feet..	13.962
Aggregate area through the back connections for draught in both boilers	square feet..	26.791
Aggregate area through the upper flues of both boilers	do..	14.157
Cross-area of smoke-pipe	do..	14.700
Aggregate heating surface in the furnaces of both boilers	do..	224
Aggregate heating surface in the lower flues of both boilers	do..	440.836
Aggregate heating surface in the upper flues of both boilers	do..	1,281.614
Aggregate heating surface in the combustion chambers of both boilers	square feet..	116
Aggregate heating surface in the back connections of both boilers, square feet		304
Aggregate heating surface in the front connections of both boilers, square feet		112
Total water-heating surface in both boilers	square feet..	2,478.5
Total superheating surface in both boilers	do..	204
Ratio of grate to cross-area over bridge-walls		5.429:1
Ratio of grate to cross-area through lower flues		6.828:1
Ratio of grate to cross-area through back connection		3.558:1
Ratio of grate to cross-area through upper flues		6.743:1
Ratio of grate to cross-area through chimney		6.485:1
Ratio of water-heating surface to grate-surface		26:1
Height of the center of the steam-pipe opening above the normal level of the water in the boilers	feet..	11.5

The weights in the boilers are distributed as follow :

	Pounds.
Wrought-iron and steel in the shells of both boilers	62,971
The flues in both boilers	18,425
Braces in both boilers	10,420
Rivets, socket-bolts, manhole plates, &c	14,618
Safety-valves, stops, checks, ash-pans, and floor-plates	14,394
Smoke-pipe, cape, and casing	3,599
Weight of water in both boilers	69,197

There are two screw-propellers, one right and one left, of cast iron, the blades curving backward, the edges curved, the forward or leading corner being curved to a radius of 17 inches, and the trailing corners curved to a radius of 16 inches. The length of the blades, on the line of the axis of the screws, is from 23 to 26 inches. The principal dimensions are as follow :

Diameter	feet..	9
Greatest diameter of the hub	inches..	17 $\frac{1}{2}$
Pitch (uniform)	feet..	14 $\frac{1}{2}$
Number of blades, each		4
Fraction of the pitch used, from		0.2696 to 0.5898
Helicoidal area of each screw	square feet..	42.02
Thickness of blades at fillet of hub	inches..	4 $\frac{1}{2}$
Thickness of blades at periphery	do..	$\frac{1}{2}$
Weight of each screw	pounds..	4,038

THE POWER, ITS DISTRIBUTION AND THE SPEED OF THE SHIP.

The nature of the service of the ship is such that uninterrupted voyages of considerable length seldom occur, and as errors in experiments are principally in the beginning and ending, it follows that short tests must be less reliable than long ones. For this reason I determined to select one of our longest uninterrupted voyages, when the vessel's bottom was clean and when she was near her average draught of water for steaming. This opportunity occurred about seven months after the ship had been put in commission, the voyage being from the New York navy-yard to the Washington navy-yard. The coal used was anthracite, containing more than the average percentage of ash and clinker. The fires were not urged, there being no desire to make a quick voyage, so that the performance must be considered as the average and not the maximum. The wind was light but ahead; the sea was smooth.

Duration of voyage.....	hours..	42½
Total distance, in geographical miles of 6,086 feet.....		423
Mean number of geographical miles per hour.....		10. 03
Total number of revolutions of the starboard engine.....		200, 197
Total number of revolutions of the port engine.....		200, 411
Mean number of revolutions per minute of the starboard engine.....		79. 05
Mean number of revolutions per minute of the port engine.....		79. 06
Slip of the starboard screw in per cent of its speed		14. 74
Slip of the port screw in per cent of its speed		14. 75
Mean steam-pressure in the boilers in pounds per square inch above the atmosphere		60. 05
Mean pressure per square inch above zero in the starboard receiver.....		25. 53
Mean pressure per square inch above zero in the port receiver.....		23. 78
Mean vacuum in the condenser, in inches of mercury.....		24. 46
Mean height of the barometer, in inches of mercury.....		30. 09
Mean position of the throttle-valves, in eighths.....		7. 20
Mean point of cutting off in the starboard high-pressure cylinder, in inches.....		26. 333
Mean point of cutting off in the starboard low-pressure cylinder, in inches.....		14. 032
Mean point of cutting off in the port high-pressure cylinder, in inches....		19. 78
Mean point of cutting off in the port low-pressure cylinder, in inches....		17. 831
Total number of pounds of coal (anthracite).....		42, 865
Total number of pounds of ashes, clinkers, &c.....		8, 353
Total number of pounds of combustible.....		34, 512
Mean number of pounds of coal per hour.....		1, 016. 97
Mean number of pounds of combustible per hour.....		818. 79
Percentage of refuse in coal		19. 40
Mean number of pounds of coal per hour per square foot of grate surface..		10. 667
Mean number of pounds of coal per hour per square foot of heating surface.		0. 4103
Mean number of pounds of combustible per hour per square foot of grate surface		8. 598
Mean number of pounds of combustible per hour per square foot of heating surface		0. 3303
Mean number of strokes per minute of the circulating-pump		80
Mean temperature of the external atmosphere		73. 73
Mean temperature of the injection-water		65. 73
Mean temperature of the discharge-water		93. 78
Mean temperature of feed-water.....		76. 39
Mean temperature of the engine-room		119. 10

HORSES-POWER.

Indicated horses-power developed in the starboard high-pressure cylinder.	93.460
Indicated horses-power developed in the starboard low-pressure cylinder..	122.240
Indicated horses-power developed in the port high-pressure cylinder.....	110.224
Indicated horses-power developed in the port low-pressure cylinder.....	131.602
Aggregate indicated horses-power developed in the starboard engine.....	215.700
Aggregate indicated horses-power developed in the port engine.....	241.206
Horses-power required to work the starboard engine.....	22.116
Horses-power required to work the port engine.....	22.118
Net horses-power applied to the starboard shaft.....	193.584
Net horses-power applied to the port shaft.....	219.708
Horses-power absorbed in friction of the load on the starboard engine....	14.519
Horses-power absorbed in friction of the load on the port engine.....	16.478
Horses-power expended in the slip of the starboard screw.....	23.278
Horses-power expended in the slip of the port screw.....	26.838
Horses-power expended in friction of the starboard screw-blades and shaft on the water.....	21.278
Horses-power expended in friction of the port screw-blades and shaft on the water.....	21.279
<i>Net horses-power applied to the propulsion of the hull.....</i>	<i>289.642</i>

DISTRIBUTION OF THE POWER.

Percentage of the net power applied to the shafts absorbed in friction of the load.....	7.500
Percentage of the net power applied to the shafts absorbed in the friction of the screw-blades, hubs, and shafts on the water.....	10.297
Percentage of the net power applied to the shafts absorbed in the slip of the screws.....	12.122
<i>Percentage of the net power applied to the shafts utilized in the propulsion of the hull.....</i>	<i>70.081</i>

ECONOMIC RESULTS.

Pounds of coal consumed per indicated horse-power per hour.....	2.222
Pounds of coal consumed per net horse-power per hour.....	3.246
Pounds of combustible consumed per indicated horse-power per hour....	1.789
Pounds of combustible consumed per net horse-power per hour.....	2.613
Pounds of coal per mile.....	101.336
Pounds of combustible per mile.....	81.588

THRUST OF THE SCREWS.

The net power applied to the propulsion of the hull by the two propellers, being 289.642 horses, is equal to $(289.642 \times 33,000 =)$ 9,558,186 foot-pounds of work per minute, and, the speed being 10.03 knots per hour, is equal to $\left(\frac{10.03 \times 6086}{60} =\right)$ 1017.376 feet per minute; therefore, the resistance of the hull (and the equivalent thrust of the screws) at that speed was $\left(\frac{9,558,186}{1017.376} =\right)$ 9,395 pounds.

The thrust per indicated horse-power, at that speed, was $\left(\frac{9395}{457.526} =\right)$ 20.31 pounds, and per pound of coal per hour it was $\left(\frac{9395}{1016.97} =\right)$ 9.23 pounds.

POWER ABSORBED BY THE FRICTION OF THE WETTED SURFACES
OF THE HULL AGAINST THE WATER.

Taking the resistance of the water to a square foot of smoothly-painted surface of the hull, moving at a velocity of 10 feet per second, to be 0.45 of a pound, and (according to the method of Chief Engineer Isherwood, U. S. N.) deducing from the speed of the vessel the mean speed of its immersed surfaces due to the inclination of the water-lines, there results a speed of 16.35076 feet per second and a consequent surface resistance of $(10^2 : 0.45 :: 16.35076^2 :)$ 1.203063 pounds per square foot at that velocity. The aggregate wetted surface during the above-mentioned voyage was 7350.44 square feet, and the power expended in this resistance was $\left(\frac{7350.44 \times 1.203063 \times 16.35076 \times 60}{33000} = \right)$ 262.893 horses; consequently, of the 289.642 horses-power required to propel the hull, $\left(\frac{262.893 \times 100}{289.642} = \right)$ 90.73 per cent was expended in overcoming the friction of the hull on the water, and the remaining 9.27 per cent was expended in displacing the water and overcoming the pressure of the wind against the upper part of the hull, the spars, and the rigging.

SVEDBERG GOVERNORS.

In a heavy sea-way a ship, from excessive pitching, will sometimes throw the screw out of water sufficiently to relieve it of the resistance of the water; at such times the screw and engine, thus released, will spin around very rapidly, endangering the machinery. To prevent this it was formerly the custom to station a man at the throttle who would close that valve when the engine began to speed up (to "race"), and to open the throttle when the engine slowed down. This operation was never satisfactory, and gave birth to the invention of many marine governors, the majority of which were centrifugal in principle, and consequently depended on the speeding of the engine to close the throttle, or, in other words, to slow the engine after the racing had commenced. The object of the Svedberg governor is to anticipate the racing and to close the throttle-valve before it commences.

To accomplish this an air-chamber A, Plate XVIII, is placed at the stern of the ship, as low down as it can be fixed; the top of this air chamber is connected to the top of a mercury-cup by a pipe; this mercury-cup (B, Plate XVIII) is made on the principle of a Wolf jar, and besides mercury it contains a wooden float on the lower end of the rod *r*, which passes through the oblique cylinder *d* to the surface of the mercury; the cylinder, though in the same casting with the mercury-cup, has its lower rim immersed in the mercury. Any elevation of the stern of the ship, or any rise or fall of the water under the stern of the ship, will increase or diminish the pressure in the air-chamber A, which pressure is promptly communicated to the mercury-cup B, and depresses or lifts the surface of the mercury in the cup; but as the lower rim of the

oblique cylinder *d* is immersed in the mercury, any rise in *B* will depress the mercury in *d*, and will cause the float (and rod *r*) to fall or rise accordingly; and this rise or fall is directly proportional to the pressure at the stern of the ship. The pressure exerted by the float is necessarily small, while the power required to move the throttle-valve is sometimes considerable, and for this reason a steam-engine is interposed, the float moving the valve of the little engine, while the pressure of steam in the little cylinder moves the throttle. In this engine the piston and rod are fixed, while the cylinder moves upon the piston; the valve chest and cylinder are cast in one, and the steam and exhaust pipes slide through stuffing-boxes; the cylinder is connected by the rod *e* to the throttle-valve lever. The action of the machine is as follows: The water, rolling from under the stern, causes a diminution of pressure in the air-chamber, which is transferred to the mercury-cup, lifts the float and rod *c*, and, through the levers (shown in the engraving), communicates a definite amount of motion to the valve; steam is thus admitted to the cylinder and moves it to the right until the motion of the cylinder has equaled that of the valve, when the ports are thus automatically closed, and the cylinder and throttle-valve come to rest. By changing the quantity of mercury in the cup, adjusting the length of the rods or throw of the levers, the throttle-valve can be made to come to rest at any desired position, or to work between desired limits. In practice the machine works admirably, surpassing the writer's most sanguine expectations.

STEAM PUMPS.

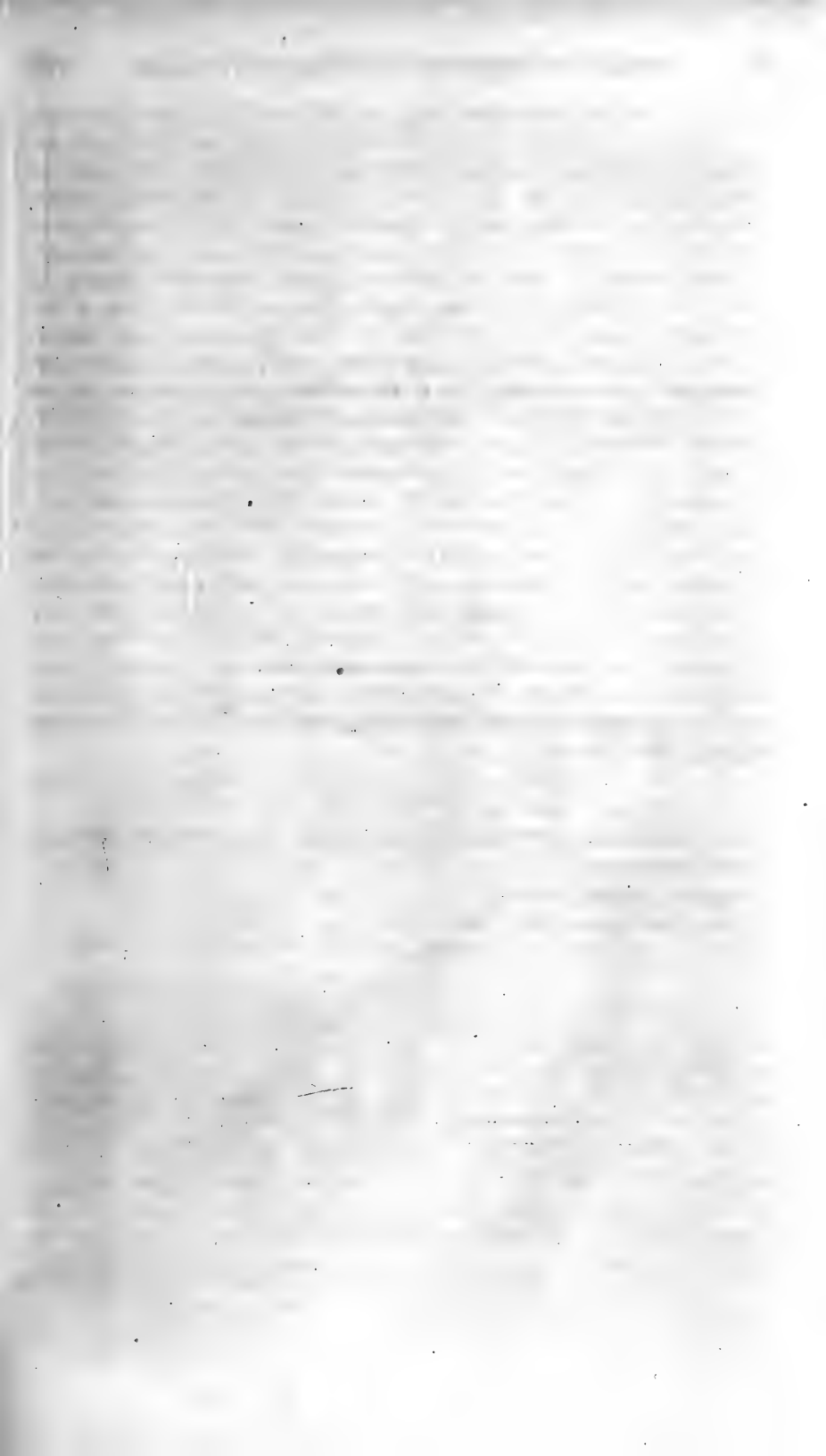
The Albatross is provided with three steam pumps, of the Davidson pattern, as follows:

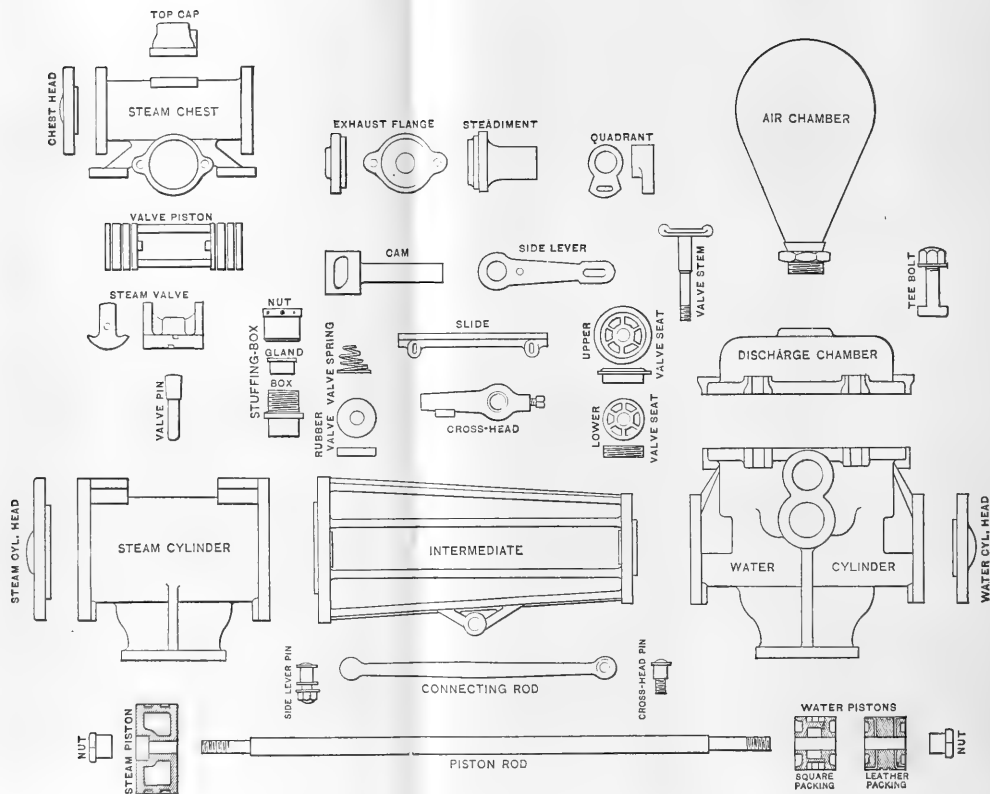
Circulating pump, No. 26. Light service.

Boiler feed or fire pump, No. 5. Regular.

Hydrant pump, No. 5. Light service.

The circulating pump has a steam cylinder 14 inches in diameter of bore, a water cylinder 16 inches in diameter, and a stroke of piston of 14 inches. Its speed may be varied from 1 to 200 strokes per minute, its ordinary speed being about 75 strokes per minute. It is piped to pump from the sea or from the bilge, and to discharge into the condenser. Its maximum capacity is about 2,400 gallons of water per minute. The writer has indicated the pump at several speeds, and constructed a curve (Fig. 1) in which the length of the ordinates refers to the indicated horses-power and the abscissas to the interval between speeds. The power of the pump can be ascertained at any moment by counting the strokes per minute and referring to Fig. 1. The boiler





Face page 29.

FIG. 2.--Details of pumps.

feed or fire pump (Plate XXVI) is proportioned to work against great pressures; it is piped to take water from the sea or from the bilge, and to deliver to the boilers, to the hydrant pipe (which delivers water to hydrant connections on the side of the deck house, to the laboratory, the engine room, and fire room), to the ash-chute, or overboard, at pleasure. The steam cylinder is 9 inches in diameter, the water cylinder is $5\frac{1}{4}$ inches in diameter, and the stroke of piston is 12 inches. The maximum capacity of this pump is about 250 gallons per minute.

The hydrant pump has a 7-inch steam cylinder, a 5-inch water cylinder, and a stroke of piston of 10 inches. It is piped to take water from the sea or the bilge and will deliver it to the boilers, the hydrant pipe, the ash-chute, or overboard; its maximum capacity is about 200 gallons per minute.

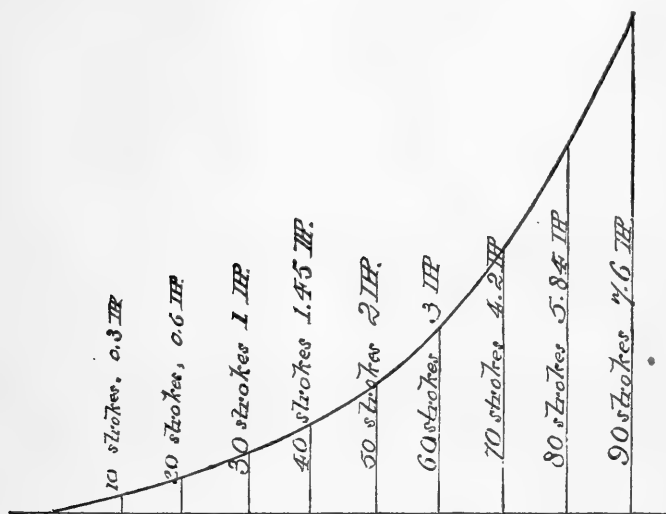


FIG. 1.

The three pumps are similar in design and in detail, differing only in size and proportion. Fig. 2 shows the details and commercial names of the parts.

The parts of the pumps are manufactured to gauges and are interchangeable; the water valves have unusually large openings; the steam valves have positive motion as well as being "steam thrown;" the water cylinders are brass lined, the valve seats and stems, glands, and piston rods are of brass. The working parts are quite accessible.

INJECTORS.

In addition to the pumps, two "Little Wonder" injectors are provided to feed the boilers. They take the water from the hot-well or from the sea and deliver only to the boilers. They are especially useful in feeding from the sea in cold weather, as they warm the water before

delivering it to the boilers. We have never succeeded in working both at a time, though they work very well singly, and it rarely occurs that we are obliged to use a steam-pump to feed the boilers.

ASH ELEVATOR AND CHUTE.

Plate XIX shows a half section of the vessel at the center line of the ash-chute, and Plate XX shows several views and sections of the hoisting engine. The object of this machinery is to hoist the ashes and dump them overboard with the least manual labor and to avoid carrying them across the deck. The vertical chute through the ship's bottom has been tried and abandoned, as the ashes soon scoured through the bottom plates of the ship, in the wake of the chute. The steam ejectors, tried in the navy, were abandoned for the reason that the ashes, blown at such a high velocity, very quickly scoured through a 2-inch thick cast-iron pipe; the writer, therefore, designed the diagonal tube (a 10-inch wrought-iron boiler flue) surmounted by a hopper, and the engine referred to. A stream of water ($1\frac{1}{4}$ inches in diameter) is projected into the hopper while ashes are being dumped, and the velocity of the descending cinders, though not great, is sufficient to project them quite clear of the ship's side. The hopper and elbow are of cast iron, and after two years' use they show scarcely any erosion. The principle of the engine is very old, it belonging to that class which is reversed by "changing the ports," *i. e.*, by having an arrangement by which the steam and exhaust ports are changed, the one for the other. For simplicity and fewness of parts the crank-shaft and hoisting drum are one and the same piece of cast iron; the cylinders are oscillating, their ports being in the trunnions, the motion of the cylinders opening and closing the ports; the steam-chest between the two cylinders is common to both, and has at its center a piston valve; steam enters through the end of the piston valve, and by moving this valve the steam goes to one side of the chest only; by moving the valve in the opposite direction the steam would go to the other side of the valve chest, which latter is divided, by a longitudinal diaphragm, into two compartments; the exhaust is through one side of the piston valve. By this arrangement it will be seen that when this piston valve is in its middle position no steam can pass into or out of the engine, which of course stops it; it is also manifest that a movement of the valve in one direction will cause the engine to run in one direction, and the opposite motion of the valve will reverse the engine. The piston valve is moved by a lever which has a long slot in it (*a*, Plate XX) through which the hoisting rope passes; on the rope there are two stops (knots), so situated that one will press and move the lever when the bucket is up, and the other when the bucket is down. To operate the machine two men are employed; the first one fills the bucket and moves the lever, the bucket rises to its stop and is brought to rest; the second man dumps the bucket into the chute, pulls the

lever (by a cord not shown), when the bucket descends to the floor and is again automatically stopped. The machine is noiseless and rapid in its action, has worked with certainty, and has required but little attention.

DISTILLING APPARATUS.

The distiller, patented by the writer, is the kind generally used on board American steamships. The object of the machine is to distil drinking-water. There are three block-tin coils placed inside an annular cast-iron cylinder, the coils terminating in manifolds which pass through stuffing-boxes in the heads of the cylinder, as represented in Plate XXI. To the top of the coils is screwed an air-injector *a*, which is supplied with steam at *b* and air at *c*, the velocity of the steam inducing the air current; the steam and air thus entering, molecule to molecule, thoroughly mixed before condensation. The current of seawater, forced into the condenser at *d*, passing out at *e*, keeps the surfaces of the coils cool which condense the steam within. The fresh water and air rush out of the coils at *f* and into a filter of *carbo animalis purificatus*, from which it is delivered to the ship's tanks through the opening *g*. The fresh water will absorb (dissolve) only a small portion of the air (less than $2\frac{1}{2}$ per cent of the volume under the pressure of the atmosphere), but the large excess of air injected into the steam serves to oxidize organic matter which is brought over by the steam, and this especial filter is to remove those oxides. The object of the annular jet of steam is to bring a larger surface of steam-jet in contact with the air, and the object of the annular condenser is to compel the circulating water to flow over the condensing surface. The filtering material requires to be renewed about once in two years. The commercial size of this machine is No. 4, and its capacity is 2,000 gallons per day; the daily consumption of water on board is about 250 gallons. A ton of coal will distil about six tons of water, so there is a saving of weight and space by employing the distiller on board ship. The quality of the distilled water is always the same, and I quote the words of an eminent medical director of the Navy in saying that "diarrhea has diminished 50 per cent on board our ships since the introduction of distilled water." The water is clear and, being well aerated, tastes quite as good as hydrant water; in fact it is difficult to detect it as the product of distillation.

LIGHTING.

The operation of dredging, in great depths, sometimes carries the day's work past midnight, and after the contents of the dredge are safely deposited on board, the naturalists are required to preserve the specimens, which often takes two hours longer. To facilitate this the commissioner authorized the installation of the Edison incandescent system of electric lighting. The plant consists of an $8\frac{1}{2}$ by 10 inch Armington

and Sims engine, an Edison Z dynamo (Plate XXII) having vertical field magnets, a resistance-box in the magnetic field-current, the necessary wiring, lamp fixtures, safety-catches, and lamps.

THE ENGINE.

The steadiness and uniform brilliancy of the lamps depends so largely on the engine driving the dynamo that Mr. Edison has adopted the best (though quite expensive) engine he could find, which is manufactured at Providence, R. I., by Armington & Sims. The great success of this engine lies in the correct balancing and lightness of its working parts, large bearing surfaces, early exhaust closure, and in its extremely sensitive governor. It has a piston valve, which has considerable exhaust lap, which serves not only to "cushion" the piston past its centers but to save the steam thus compressed in the clearance spaces. The engine runs 300 revolutions per minute, and is belted to and drives the dynamo 1,200 revolutions per minute. The governor of the engine is fixed in the fly-wheel,

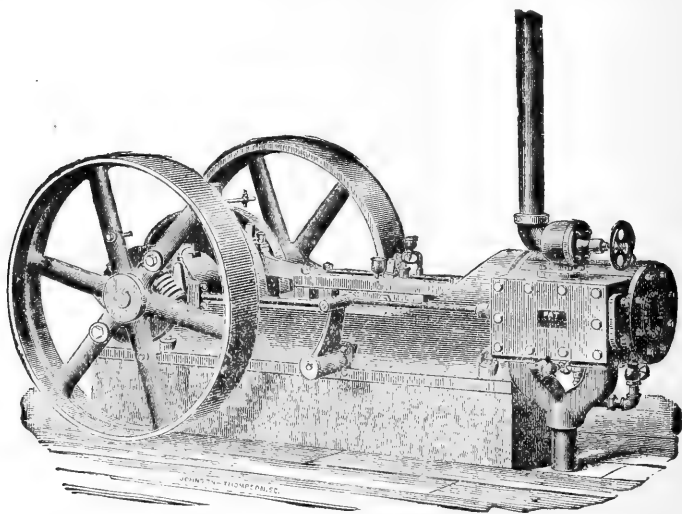


FIG. 3.

which is keyed to the shaft; there are two eccentrics, one within the other, and both movable on their axis; there are two weights, with their centers of motion opposite, and fixed in arms of the wheel; these weights are each connected to one of the eccentrics and connected by an arm or rod; spiral springs (Fig. 3), to resist the centrifugal force of the weights, are provided; the system is so constructed that any centrifugal motion of the weights will throw one eccentric ahead and the other back, thus diminishing the throw of the eccentrics and effecting a shorter cut-off, without changing the lead of the valve. When the main engines of the ship are in motion, we use a boiler pressure of 50 pounds above the atmosphere and exhaust all engines (including the dynamo engine) into

the condenser, where there is from 23 to 26 inches of vacuum ; lying in port, we let the boiler pressure fall to 25 pounds and exhaust the dynamo engine against pressure of the atmosphere ; and notwithstanding this great difference of pressure between the two conditions, the governor of the dynamo engine so regulates the quantity of steam to the cylinder that the revolutions of the engine remain practically at 300, never varying more than 2 per cent. The engine and the dynamo are run by enlisted men in the engineers' department.

THE DYNAMO.

The dynamo (Fig. 4) is of the size known as Z, and is wound for what is called a B circuit, *i. e.*, a circuit which will give 51 volts of electromotive force, and generate a current for 120 lamps, each requiring 0.745 amperes, offering a resistance of 69 ohms. The field magnets are

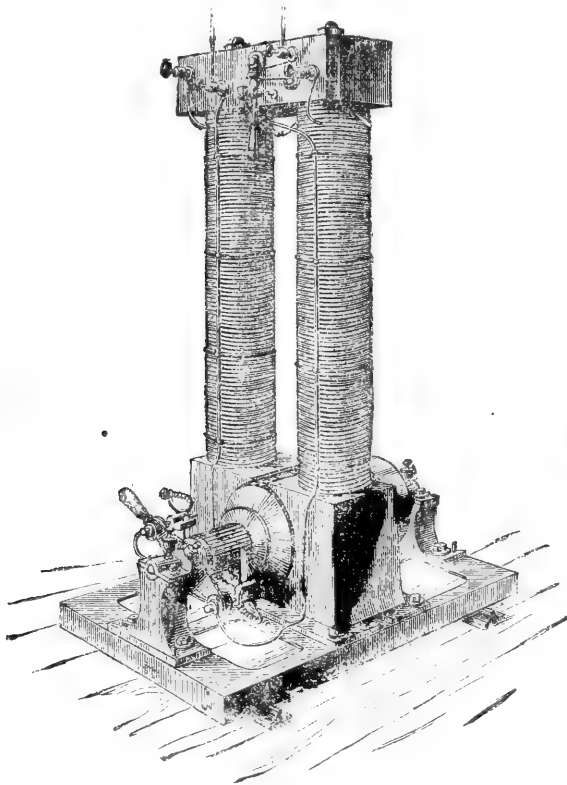


FIG. 4.

vertical, and the armature revolves on a horizontal axis, in the magnetic field. The field magnets are arranged on what is called a "derivation" or "shunt" from the commutator, placing it in the circuit as in the Siemens system. In adapting and utilizing known principles and devices and in patiently working out details, Mr. Edison has brought his system of lighting to an admirable state of perfection ; wherever the eye rests

it is pleased by correct proportions, sound mechanical principles, and agreeable outlines.

To preserve the uniformity of the current an adjustable resistance-box is placed in the field circuit, so that when a number of lamps are extinguished additional resistance may be thrown into the field by a switch on the resistance-box, whereby the internal and external resistance may be balanced, preserving not only the uniform brightness of the lamps, but also the economy of the machine.

THE WIRING.

The wires are all of copper; those well protected from dampness are insulated with a woven cotton and white lead covering; where they pass damp or wet places they are further incased in rubber tubes; where they pass hot places (through the boiler room) they are run through lead tubes; and where they pass through iron bulkheads they are protected by hard-rubber tubes. There are two complete circuits round the ship; in the event of an accident to one circuit (by collision, for example) the lamps will be fed by the other. These main circuits, on board ship, are necessarily doubled or even tripled, as the short bending of a large wire or rod, or hauling it through holes in iron or wood, would be apt to injure the insulation besides increasing the labor. No. 10 is, therefore, the largest wire, and No. 20 the smallest wire used in our circuit.

Where a wire—main wire or branch—passes along a surface of iron, as a lodger plate, it is fitted in a groove in a wooden batten, and never permitted to touch the iron; when it passes a wooden surface, a groove is cut to let it in, and it is puttied and painted over; wherever possible the wires are led out of sight. Wherever splicing or tapping of wires was necessary, the ends were cleared of the insulation, cleaned with sand-paper, soldered, and recovered with a bituminous mixture called "insulation compound," and finally tightly covered with tape; these joints are thus as well protected as any part of the wire.

LAMP FIXTURES.

The lamp fixtures are designed to suspend above and cast the unobstructed rays of light downward. Handsome brass fixtures with por-

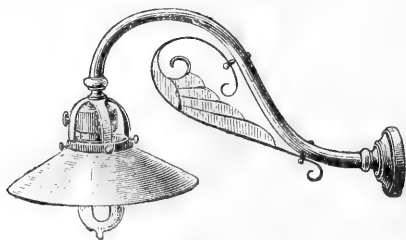


FIG. 5.

celain shades of three kinds are used on board. Fig. 5 is called a bracket, Fig. 6 a single-swing bracket, and Fig. 7 a double-swing bracket.

The wires are run through the tubes of these brackets, but in the joints of the swinging brackets the current is transmitted through insulated hinges, to which the wires are fixed by binding screws, as shown at *a* in Fig. 8, by which arrangement the wires are not twisted in swinging the bracket. The wires are brought to the binding posts in the lamp-socket, Fig. 9, between their binding screws and brass conductors; one of these brass conductors is soldered to the thin-spun brass socket into which the lamp is screwed while the other is connected, through the key, to a brass disk placed centrally in the bottom of the socket, against which one pole of the lamp presses when screwed in place. The key is mounted on a screw-thread of such pitch that one-fourth of a revolution will give it sufficient axial motion to open or close the circuit. The small number of parts used in these fixtures, their correct proportions, the adaptation of their forms to machine tool manufacture, and their beauty of design excite the admiration of both artists and mechanics.

FIG. 6.

THE LAMPS.

The lamps are of thin glass, pear-shaped, containing a thread of bamboo carbon about as thick as a horse-hair. The small end of the lamp (Fig. 10) contains glass of sufficient thickness to make a tight joint on the platinum wire conductors which carry the current to the carbon. The atmosphere is exhausted by Edison's modification of the Sprengel pump, through a tube at the lower end of the lamp, and the tube is then fused and broken off. Platinum wire is used because its index of expansion is the same as that of glass, thus preventing any breakage or leakage from the heat. The bamboo-carbon, and platinum wire are soldered together by electrically-deposited copper. One wire, passing through the glass, is soldered to a small brass disk which is centered on the top of the lamp (Fig. 10), while the other wire is soldered to the spun-brass screw-thread which surrounds the cylindrical part at the top of the lamp, and when the lamp is screwed into the socket (Fig. 11) the circuit is completed or broken by the switch or key already described.

When the circuit is closed the carbon thread becomes heated to incandescence—from its high resistance—and continues to glow, in vacuum, without burning, so long as the cur-

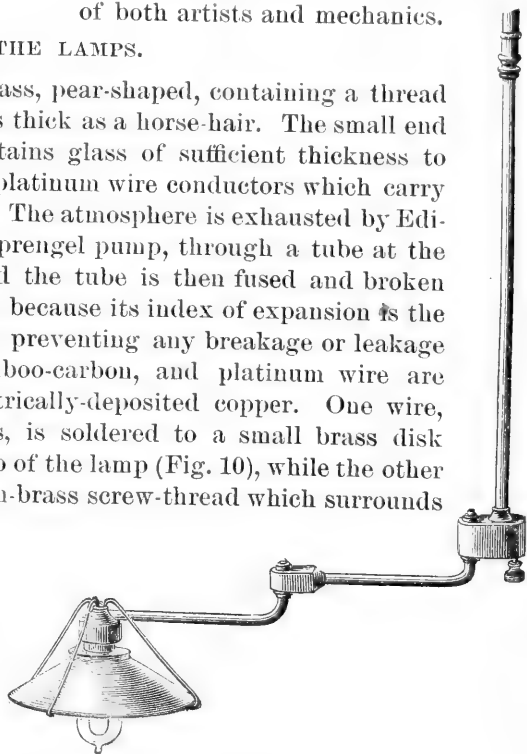


FIG. 7.

rent continues to flow. Fig. 12 shows a lamp screwed into its socket.

By varying the length, and also the sectional area of the carbon

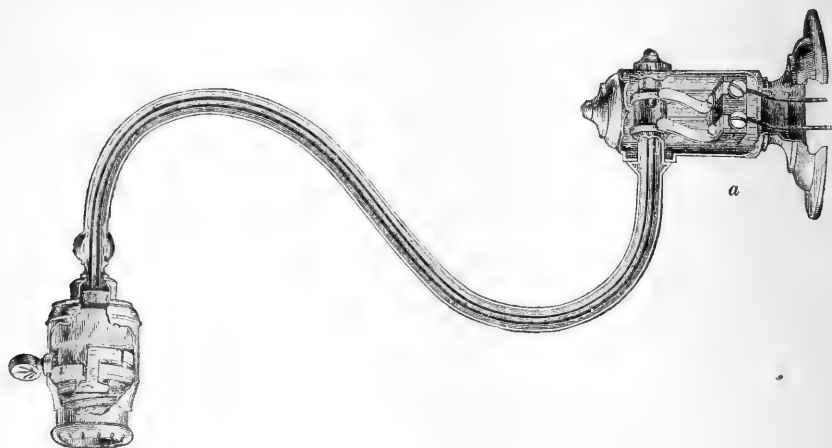


FIG. 8.

thread, keeping the electro-motive force constant, Edison has varied the candle-power of his lamps. In our circuit we have a few 16 candle-power lamps, though most of them are of 8 candle-power only. The cop-

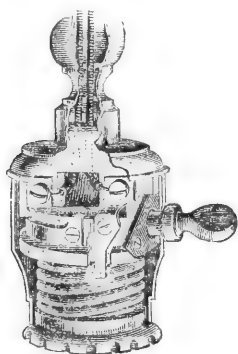


FIG. 9.



FIG. 10.

per wires, being of high conductivity, and of ample size, carry the current with but little warming, notwithstanding the white heat of the carbons in the circuit; by varying the size of the wires it will be found they follow the same law as to resistance and heating as the carbons.

Let R = the resistance of a conductor; S = its sectional area; L = its length; a = a constant depending on material of which the conductor is made; then $SR = aL$, and from this simple equation the relative sizes of the wires and carbons have been determined.

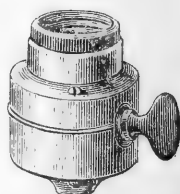


FIG. 11.

The "life-time" of these lamps is warranted to be 600 burning hours, and their cost is 85 cents apiece.

SAFETY CATCHES.



FIG. 12.

In event of a "short circuit" (an accidental connecting of the + and - wires) by a good conductor there would instantly be generated sufficient heat in the wires to melt them and to set fire to the adjacent woodwork, and possibly melt the armature also. To prevent this, Mr. Edison has devised his cut-out blocks and safety plugs shown in Figs. 13 and 14. The wires of the circuit connect to the binding screws in the blocks, while the plugs screw into the sockets of the blocks when the circuit is completed through the plugs, after the manner of the lamps; but the wire which connects the two poles of the plug is made of a fusible alloy, which melts at about 400 degrees, and the melting of this wire breaks the circuit. When this happens all the lamps fed through that plug will go out. These safety catches are placed on the main

wires near the dynamo and on every branch circuit near the point where the mains are tapped.

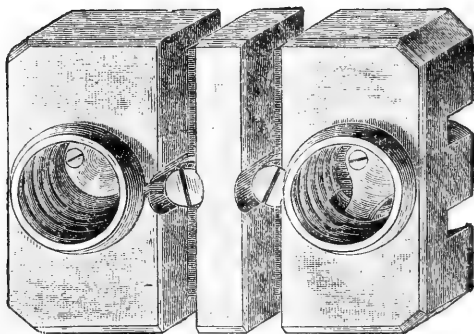
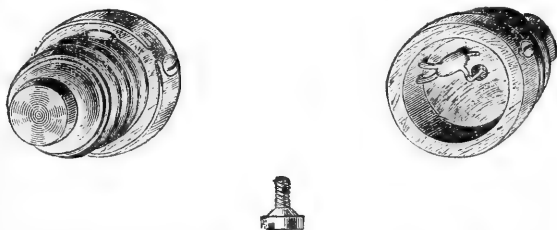


FIG. 13.

ECONOMY OF THE SYSTEM.

The writer indicated the engine with the current switched off; again with forty-five, with fifty, and finally with seventy lamps (8 candle-

power B lamps) in circuit, respectively. By deducting from these experiments, respectively, the power required to run the engine and dynamo we obtain the power applied to the shaft, and from this quan-

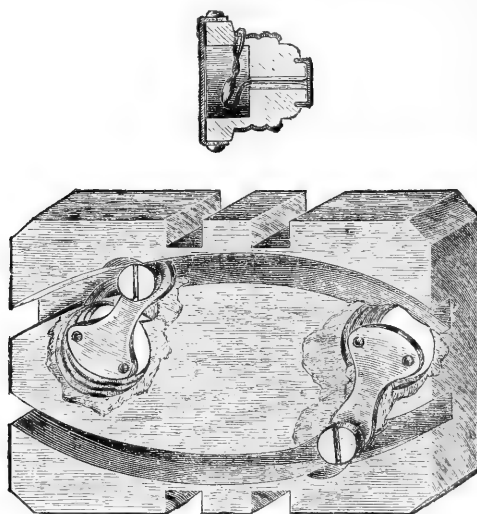


FIG. 14.

tity we deduct the friction of the load, leaving as a remainder the net power required to revolve the armature in the magnetic field with those respective lamps in circuit.

DISTRIBUTION OF THE POWER.

Horses-power required to run the engine and dynamo.....	3.56
Indicated horses-power required to run 45 lamps.....	5.79
Indicated horses-power required to run 50 lamps.....	5.85
Indicated horses-power required to run 70 lamps.....	6.92
Net horses-power applied to the revolution of the armature in the magnetic field, using 45 lamps.....	1.80
Net horses-power applied to the revolution of the armature in the magnetic field, using 50 lamps.....	1.85
Net horses-power applied to the revolution of the armature in the magnetic field, using 70 lamps.....	2.84
Mean number of lamps, per indicated horse-power, using 45 lamps.....	7.77
Mean number of lamps, per indicated horse-power, using 50 lamps.....	8.50
Mean number of lamps, per indicated horse-power, using 70 lamps.....	10.11
Mean number of lamps, per net horse-power, using 45 lamps.....	25.00
Mean number of lamps, per net horse-power, using 50 lamps.....	27.02
Mean number of lamps, per net horse-power, using 70 lamps.....	24.63
Mean of the last three quantities.....	25.55

So far the greatest number of lamps in operation at any one time has been (to the best of the writer's knowledge) 70, and he believes the average number to be about 47. The number of lamps, per indicated

horse-power, increases with the number of lamps used, for the reason that the fraction of the power utilized becomes larger at the higher power. The cost, in coal, of a horse-power developed by the dynamo-engine has been arrived at by calculating the quantity of steam passed through the steam-cylinder and reducing this to pounds of water evaporated by a pound of coal. Had steam been used for the light alone this calculation would have been unnecessary, but as it was used from the same boiler to warm, ventilate, and light the ship at the same time, the writer adopted this method of separating the respective quantities. From these indicator diagrams I have calculated that a horse-power costs 30.7 pounds of water or 3.41 pounds of coal per hour. The mean cost of coal during the two* years the ship has been in commission has been \$6.07 per ton, or 0.271 cent per pound. The total cost of the oil used on the dynamo and its engine has been \$106.74.

During the year 1833 the dynamo was in operation 1,592 hours and 45 minutes, and during 1884 1,481 hours and 30 minutes, making a total of 3,074 hours and 15 minutes.

The cost of running the plant for the two years has been—

Total cost of coal:

For 1883	\$79.60
For 1884	95.51

Total cost of oil:

For 1883	48.57
For 1884	58.17

2 K brushes	5.00
11 Z brushes	11.00
2 cut-out blocks .....	.64
73 3-light cut-out plugs	5.84
16 6-light cut-out plugs .....	.48
5 20-light cut-out plugs .....	.40
13 40-light cut-out plugs	3.20
5 key-sockets	4.60
2 pounds of insulation compound .....	.24
1 wire shade-holder .....	.10
$\frac{1}{2}$ pound insulation tape .....	.24
2 attachment plugs .....	.80
3 pounds No. 14 insulated wire	1.20
1 pound No. 20 insulated wire .....	.40
1 new valve for the engine	5.00
1 new cross-head for the engine	25.00
1 new belt	20.00
Repairs (shortening) of belts	5.62
241 lamps†	241.00

Total expenditure, exclusive of labor and interest 665.97

*These figures include the work for 1883 and 1884.

†The lamps do not now come in the writer's department on board, but are here entered to complete the account.

As the engine and dynamo are run by a coal-heaver in addition to other duties, the writer has not entered the item of wages.

As the price of the lamps has been reduced 15 per cent, and the price of fixtures continues to diminish, we have no doubt that the running expense of the light will grow less. During 1884 we paid as high as \$18 a ton for coal, at Aspinwall, and in 1883 as low as \$3.93 a ton, at the Norfolk navy-yard. Between such ranges the cost of the light must vary, but as the writer has included all the coal consumed on board for that purpose during the entire period of the ship's existence, he believes the mean will be found to be very close to the correct one.

A correct average number of lamps cannot be ascertained where they are being turned on and off by so many persons, but the writer's average, taken from a number of observations, places the number at $47\frac{1}{2}$. Assuming this to be correct, the cost of the light in candles-power per hour becomes

$$\frac{66597}{(1592.75 + 1481.5) 47\frac{1}{2} \times 8} = .05707 \text{ cent.}$$

This is about 38 per cent more than the cost of an equivalent amount of gas-light in Washington City, where coal costs less than \$5 per ton.

DEEP-SEA LAMPS.

Our deep-sea cable is 940 feet in length and is coiled upon a reel, from which it may be paid out to any depth within that limit. The lamps are according to Edison's patent, but the wires simply extend through the bottom of the lamp, the ends being free. We solder these wires to our cable, insulate with gutta-percha, tape, and "insulation compound." The lamps are of about 42 ohms resistance and are about 16 candle-power. The lamps burn quite well under water and can be seen very plainly at moderate depths, but they disappear entirely when 70 feet below the surface. We have had the deep-sea lamp down about 750 feet. There are two other submarine lamps, having each about 40 feet of cable with attachment plugs, so that they can be attached to any lamp socket. These have been used by the naturalists, who immerse them a few feet beneath the surface of the water to attract marine animals; by this means they have secured squid in large numbers, amphipods, silver-sides, young bluefish, young lobsters, and flying-fish, and dolphins have been seen to approach these lamps.

WARMING AND VENTILATING.

Experiments made by the writer on two wooden ships of the Navy show that 1 square foot of steam "radiator" surface is sufficient to warm 1 cubic foot of space on shipboard, even in the coldest weather, and he employed that rule in proportioning the steam radiators for the Albatross. The simplest forms of radiators were adopted, and we find, in practice, that they are quite as "noiseless" as the patented radiators, when properly piped for draining. In the pilot-house we adopted a plain return-

bend brass coil ; in the deck-house rooms we put single columns ; in the cabin, ward-room, laboratories, captain's office, and chart-room, and berth-deck apartment we put common steam radiators having cast-iron rectangular bases with vertical 1-inch wrought-iron tubes, 35 inches high, screwed into the open bases. The 1-inch (inside diameter) tube, 35 inches long, gives, in round numbers, 1 square foot of surface, making the distribution of the surface quite simple. Among the advantages of steam heat on board ship are cleanliness, easy regulation, economy of space, and safety.

The water condensed from the steam in the radiators is trapped and conveyed into the "hot well" (whence it is pumped into the boilers) or into a tank which is used as a reservoir for washing water.

The ventilation is effected by a single Sturtevant exhaust fan, driven directly from a "Wise motor," shown in Fig. 15. The fan has openings

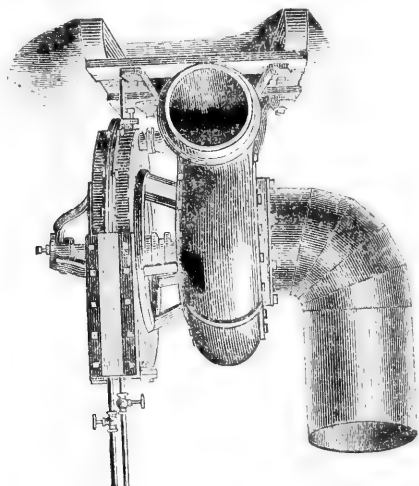


FIG. 15.

of 14 inches diameter, both for receiving and for discharging the air; there are two branch (11-inch) pipes from the suction side of the fan, one running to each side of the ship, and these 11-inch pipes branch into a 9-inch pipe leading forward and a 7-inch pipe leading aft, on each side of the ship. There is a sliding gate in each of the 9 and 7 inch conduits, near their connection with the 11-inch mains, which enables us to close either section; this would be essential in case of fire. The 9 and 7-inch conduits, which run close under the lodger plates of the berth deck, diminish in size to the extremities of the ship, where they are only 3 inches in diameter. From these pipes, or conduits, we have led 3-inch diameter pipes through the deck to the apartments to be ventilated, these small pipes terminating in polished brass registers, the area through which may be regulated at will. The conduits are made of Root's spiral galvanized wrought-iron pipe, the edges riveted

and soldered, and though none of it is over No. 16 in thickness, it is amply strong for the purpose. The polished registers are made to finish with the joiner-work of the ship, and the pipes connecting them with the conduits are, wherever possible, led behind the ceiling and other joiner-work, and are quite out of sight. The fan is too well known, commercially, to warrant a detailed description here; it is sufficient to say that it is a Sturtevant No. 6 centrifugal exhaust fan, and that the ventilation of the ship is effected by drawing out the foul air, permitting the fresh air to find its own way in, to supply the void, and is known as the aspiration system. The motor, though one of the earliest forms of steam-engine, bears a recent United States Patent Office date, and is remarkable alone for its simplicity. It consists essentially of a short hollow cylinder, its axis horizontal, containing a wheel in the circumference of which there is placed a number of pockets or "buckets." The "buckets" just clear the surface of the cylinder, and revolve freely within it; there are eight steam jets, arranged in such a manner that the steam from them will impinge directly into the buckets and cause the wheel to revolve upon its axis. The shaft of the motor extends through and is also the shaft of the fan. The fan, according to the figures of the builder, requires 2.86 horses-power to drive it 1,018 revolutions per minute, at which velocity it should deliver 3,669 cubic feet of air per minute. The quantity of air and the consequent size of fan was determined from the experiments of the writer, on board the United States ship *Vandalia* in 1879.*

Let Q = the number of cubic feet of air to be supplied; n = the number of men; a = the cubic feet of carbonic acid exhaled per man per hour (.0686); b = fraction of carbonic acid normal to the external atmosphere (.0004); c = fraction of carbonic acid found in the apartment. Then

$$na + Qb = (Q + na) c$$

from which we find

$$Q = \frac{na - nac}{c - b} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

From the experiments referred to we found the value of c to equal .0006983. By substituting numericals for letters and deducing we found 2,298 cubic feet per hour per man to be necessary.† The No. 6 fan, therefore, would be ample to ventilate for the 65 people who were to compose the crew, and leave us a reserve of nearly one-third its capacity for the hold of the ship, which we also provided with registers.

It at once became a matter of interest to know what quantity of steam was being used by the motor, and to ascertain, within reasonable

* Proceedings of the Naval Institute for 1880.

† The chemical analysis of the air were made by Dr. Arthur, of the Navy; the writer is responsible for the air measurements, the method, and the correctness of the calculation.

limits, what power was produced from this. For this purpose the writer connected the exhaust-pipe from the motor with the distilling apparatus, measured the condensed water by a "crown meter" and verified it by measurement in the ship's tanks, where the water was delivered.

Experiment to determine the power and the economy of the fan-motor.

Duration of the experiment, in hours	12.
Cubic feet of water condensed from the exhaust	96.75
P=Absolute steam pressure, mean, per square inch, in pounds	63.00
T=Temperature of the water	91°
Relative volume of the steam and water	409.
Volume of steam, in cubic feet	39,570.75
Cubic feet of steam per second	0.916
A=Area of the steam jets, in square feet	0.0027266
V=Velocity of the steam, in feet, per second $\left(\frac{.916}{.0027266}=\right)$	332.2
W ₁ =Weight of a cubic foot of steam at P pressure, in pounds	0.152445
w=Weight of steam per second	0.13808
R=Radius, to center of pressure of the "buckets" or vanes, in feet ...	1.2916
N=Number of revolutions per minute	550.
U=Velocity of the vanes ("buckets"), in feet, per second	74.3944
W=Work done.	

Then

$$W = \frac{w}{2g}(V^2 - U^2) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

This assumes that the total velocity lost by the steam is utilized in power.

$$U = \frac{2\pi RN}{60}$$

and

$$w = VAW_1 = .13808 \text{ pounds of steam per second.} \quad . \quad . \quad (3)$$

Substituting in equation (2) we have

$$\frac{.13808}{64}(332.2^2 - 74.3944^2) = .00216 (110356.84 - 5533.87)$$

=226.417 pounds of work per second, or $\frac{226.417}{550}$ =0.41 horse-power.

A cubic foot of water at T degrees weighs 62.07 pounds; the volume of water condensed per hour was $\left(\frac{96.75}{12}=\right)$ 8.0625 cubic feet. Consequently, the weight of water per horse-power per hour was

$$\left(\frac{8.0625 \times 62.07}{0.41} =\right) 1220.6 \text{ pounds.}$$

During the entire experiment the two throttles on the motor were kept wide open.

Though the fan does not run as fast as expected, the air is changed

rapidly in the ship, and there is an absence of odors peculiar to ships, of the "stiffness" in the sleeping apartments, and of the sensation of headache and nausea on waking in the morning.

STEAM CUTTERS.

The Albatross is provided with two steam cutters, built by the Herreshoff Manufacturing Company, of Bristol, R. I., from their own designs. The boats have wooden hulls, the larger one being coppered; both are fastened with screws, and are built as light as is consistent with strength. They have compound engines, Herreshoff's patent coil boilers, and external surface condensers. That which distinguishes Herreshoff's system is the coil boiler fed at the top, emptying its steam and water into a separator (whence steam is fed to the engine), and a "circulating pump" which takes the excess of feed-water from the bottom of the separator and delivers it again to the top of the coil. The larger boat has its shaft parallel with the base line and has a 4-bladed screw; the smaller boat has its shaft inclined, passing through the bottom of the hull, a little to one side, and about amidships, and has a 2-bladed screw; just outside the hull there is a universal joint in the line shaft, which permits the screw being pulled close up under the bottom of the hull, with its two blades lying horizontally, in a recess left in the keel, and when thus placed the lower edge of the keel is below the edges of the screw. The object of this is to protect the screw when passing over shoals. The screw being placed under the bottom of the hull, works always in solid water, and no matter how rough the sea, the propeller is never thrown out of water, and does not "race." Fig. 16 is a cut of the double-coil boiler of the steam cutter. The feed water enters the bottom of the outer coil, passing upward and through the spiral coil, then into and down the inner coil, and finally up, through an external pipe F, and into the separator D. The gases of combustion pass through the spaces between the coils. The furnace is lined with fire-bricks to a height of about 6 inches, and the coils are supported by wrought iron straps, with stirrup bolts, resting on the fire-bricks; the casing of the boiler is of sheet iron. The lightness of the boiler, the very small amount of water it contains, its great strength, and large heating surface give it great advantages over other boilers, and its results have been admirable. The boiler of the smaller boat is similar to the one in Fig. 16, except it has not the outer coil.

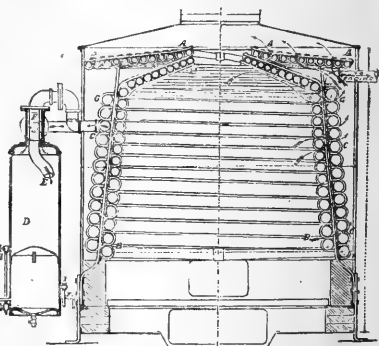


FIG. 16.

Fig. 17 is a perspective view of the engine of the cutter.

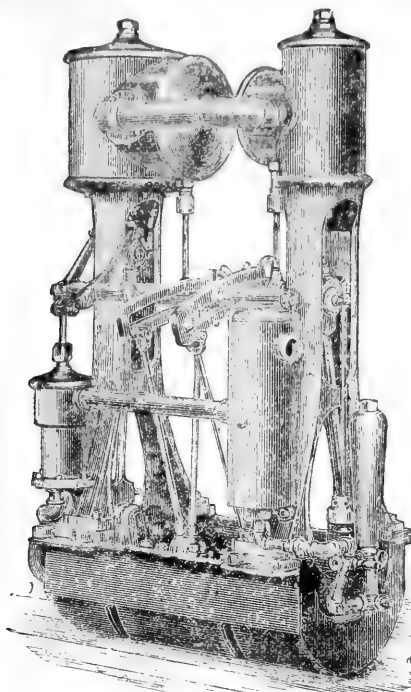


FIG. 17.

The principal dimensions of the boats and machinery are as follow :

	Large boat.	Small boat.
Length from forward edge of stem to after edge of stern.....feet..	26.500	25.083
Length at the load water-line.....do.....	24.500	24.583
Greatest beam.....do.....	6.750	5
Beam at the load water-line.....do.....	6.400	4.833
Depth from top edge of gunwale to lower edge of rabbet of keel:		
Forward.....do.....	4.333	3.500
Amidships.....do.....	3.417	2.667
Aft.....do.....	3.677	3.667
Draught of water, exclusive of keel:		
Forward.....do.....	1.667	1.417
Amidships.....do.....	1.625	1.417
Aft.....do.....	1.583	1.417
Depth of keel:		
Forward.....do.....	.25	.208
Amidships.....do.....	.625	.458
Aft.....do.....	1.000	.375
Area of greatest immersed transverse section.....square feet..	7.27	6.216
Area of load water-line.....do.....	101.65	86.67
Aggregate area of the wetted surfaces.....do.....	116.25	99.76
Displacement at the load water-line.....cubic feet..	89.29	46.86
Weight of hull and fittings.....pounds.....	3,300	1,700
Weight of boiler.....do.....	1,115	527
Weight of coal and water.....do.....	780	690
Weight of engine, including screw.....do.....	520	182
Weight of the boat complete.....do.....	5,715	3,099
Number of boilers.....	1	1
Diameter of casing of boiler.....inches..	36	26
Extreme height of boiler from ash-pit to base of smoke-pipe.....do.....	39	32

	Large boat.	Small boat.
Diameter of furnace.....inches.....	29	22
Area of grate surface.....square feet.....	4.58	2.64
Diameter of smoke-pipe.....inches.....	10	8
Height of smoke-pipe above grate bars.....feet.....	8.75	6.75
Diameter of separator.....inches.....	6	3
Height of separator.....do.....	31	26
Steam cylinders.....number.....	2	2
Diameter of high-pressure cylinder.....inches.....	31 $\frac{1}{2}$	24 $\frac{1}{2}$
Diameter of low-pressure cylinder.....do.....	6	4 $\frac{1}{4}$
Stroke of pistons.....do.....	7	5
Diameter of the piston rods.....do.....	2 $\frac{1}{2}$	1 $\frac{3}{4}$
Diameter of the air pump (single-acting).....do.....	2 $\frac{1}{2}$	2 $\frac{1}{4}$
Stroke of air pump.....do.....	2 $\frac{1}{2}$	2 $\frac{1}{4}$
Diameter of circulating pump-plunger.....do.....	7 $\frac{1}{2}$	4 $\frac{1}{2}$
Diameter of feed pump-plunger.....do.....	7 $\frac{1}{2}$	3 $\frac{1}{2}$
Stroke of pumps.....do.....	7	5
Length of condensing pipes.....feet.....	15	13 $\frac{1}{2}$
Condensing surface.....square feet.....	9.83	4.95
Main journals.....number.....	3	3.
Diameter of main journals.....inches.....	1 $\frac{1}{2}$	1 $\frac{1}{2}$ and 2 $\frac{1}{4}$
Length of main journals.....do.....	3	2 $\frac{1}{2}$
Crank-pin journals.....number.....	2	2
Diameter of crank-pin journals:		
High-pressure.....inches.....	1 $\frac{1}{2}$	1 $\frac{1}{8}$
Low-pressure.....do.....	7 $\frac{1}{8}$	1 $\frac{1}{8}$
Length of crank-pin journals:		
High-pressure.....do.....	1 $\frac{1}{2}$	1
Low-pressure.....do.....	1 $\frac{1}{2}$	1 $\frac{1}{2}$
Space occupied by the engine:		
Length fore and aft.....do.....	24 $\frac{1}{2}$	21
Width.....do.....	21	18
Height.....do.....	44	26
Diameter of the screw propeller.....do.....	28	16 $\frac{1}{2}$
Pitch of the screw propeller (uniform).....do.....	48.72	30
Projected length of the screw on line of its axis.....do.....	5	3
Blades of the screw.....number.....	4	2
Friction of the pitch used.....do.....	0.49	0.2
Helicoidal area of the screw blades.....square feet.....	3.69	$\frac{1}{2}$
Weight of the screw.....pounds.....	45	6

DREDGING ENGINE.

Plates XXIII and XXIV represent the dredging engine, the principal use of which is to hoist the trawls and dredges, but it is provided with additional "gypsy heads" for hoisting boats, &c. It was built by Copeland & Bacon, of New York, according to their patents. It has three gypsy heads (the large one of steel) mounted on the same horizontal shaft, and driven by a double-cylinder half-trunk steam-engine through the intervention of toothed gearing and a modification of Mason's friction clutch. The engines have locomotive valves which are actuated by Stephenson's links and eccentrics; the cranks are cast-iron disks; each pair of eccentrics is cast in one; the cut-off is effected by the lap on the valves. The machine has a friction brake to regulate the "paying out" of the dredge rope, and also a roller guide, with treadle motion, to press the rope aside and prevent the turns from riding. The engine is placed on the main deck, forward of the foremast; it takes its steam from the main boilers and may be exhausted either into the main condenser or into the atmosphere.

Its principal dimensions are as follow:

Greatest diameter of the large gypsy head.....inches..	36 $\frac{1}{2}$
Least diameter of the large gypsy head.....do.....	22 $\frac{1}{8}$
Length of the large gypsy head on line of its axis.....do.....	24
Diameter of the inboard end of the small gypsy heads.....do.....	21 $\frac{1}{2}$

Diameter of the outboard end of the small gypsy heads	inches..	11½
Diameter of the middle of the small gypsy heads	do....	8½
Length of the small gypsy heads on line of their axes	do....	12½
Total length over the three gypsy heads	do....	113½
Diameter of the main shaft	do....	4½
Diameter of the spur wheel at the pitch line	do....	40
Pitch of the teeth of the gearing	do....	21½
Width of the face of the gearing	do....	6
Width of the face of the friction brake	do....	4
Number of journals on the main shaft	do....	2
Diameter of the journals on the main shaft	inches..	4
Length of the journals on the main shaft	do....	13
Diameter of the pinion on the pitch line	do....	9
Number of steam cylinders	do....	2
Diameter of the steam cylinders	inches..	10½
Width of the piston trunks fore and aft	do....	9
Width of the piston trunks athwartship	do....	2¾
Area of cross-section of each trunk	square inches..	23½
Net area of the steam pistons, each	do....	74.84
Stroke of the pistons	inches..	10
Number of journals on the crank shaft	do....	2
Diameter of the crank-shaft journals	inches..	3½
Length of the crank-shaft journals	do....	6
Diameter of the crank pins	do....	1½
Length of the crank pins	do....	2
Length of the engine base fore and aft	do....	60
Width of the engine base athwartship	do....	96
Height of the engine	do....	53½
Weight of the engine	pounds..	6,500

POWER OF THE DREDGING ENGINE.

The wire rope from the dredge passes over the dredging block at the end of the dredging boom, then under a sheave in the heel of the boom, then upward and over a block suspended from the "accumulator," and then to the central (or large) gypsy head of the dredging engine.

The "accumulator" (Plate XLIV), which is a series of rubber "buffers" moving freely on their longitudinal axes by the tension on the dredge rope, becomes a good dynamometer, though its motion is small and its scale fine. By taking a large number of dynamometer readings simultaneously with indicator diagrams from the dredging engines, noting at the same time the actual velocity of the rope as it is measured by the register on the boom sheave and also the speed of the engines, and by taking the mean of these quantities we shall approach very closely to the true conditions.

The gypsy head, by which the wire rope is wound, is curved, and the rope comes in, consequently, on a varying diameter; as the mean velocity of the wire is less than that due to velocity of the center line of the wire wrapped on the smallest diameter of the head it is evident there is a slip. The tendency of the rope, winding on the head, is to coil into a helix, but the inclination of the surface causes the wire to surge

toward the central part of the head, with some jar, slipping back at the same time. The loss of power due to this slip, plus the power required to overcome the stiffness of the rope in bending it on the head, will be found by taking the difference between the net power applied to the revolution of the gypsy head and the power indicated by the dynamometer.

The diameter of the smallest part of the gypsy head is $22\frac{1}{8}$ inches, and the diameter of the wire rope is three-eighth of an inch, consequently the velocity of the rope, per revolution of the head, supposing there were no slip nor "creeping", should be $\pi \left(\frac{22\frac{1}{8} + \frac{3}{8}}{12} \right) = 6.104$ feet,* but from the reading of the register it is only 5.924 feet.

The following record is from the mean of a number of observations made by the writer and assistants:

Velocity of the rope indicated by the register, in feet, per minute.....	148.600
Velocity of the rope due to the smallest diameter of the gypsy head.....	153.100
Tension on the wire, in pounds, indicated by the dynamometer.....	2,737.5
Revolutions of the gypsy head per minute.....	25.083
Revolutions of the engine per minute.....	107.500
Indicated horses-power developed by the engine.....	15.563
Indicated horses-power required to work the engine.....	1.453
Horses-power absorbed by the friction of the load.....	1.167
Net horses-power applied to the tension on the rope.....	12.943
Horses-power accounted for by the dynamometer.....	12.327
Horses-power absorbed by the slipping and bending of the rope on the gypsy head.....	.616

The 15.563 horses-power indicated by the engine is divided as follows:

	Per cent.
For pulling in the rope.....	79.207
For working the engines.....	9.335
For overcoming the friction of the load.....	7.500
For overcoming the slip and bending of the rope.....	3.958
	100.000

REELING ENGINE.

The reeling engine, Plate XXV, was built by Copeland & Bacon, of New York, and is of the same character of design as the dredging engine. Its object is to stow the wire rope, and to keep a limited tension on that rope when in motion. It is essentially a wrought-iron, built-up drum, mounted on a horizontal axis, driven by a double-cylinder half-trunk steam-engine, through the intervention of toothed gearing and a friction clutch. It has a friction brake to regulate the paying out.

It is provided with a traveling guide, mounted in front of the drum, for guiding the rope smoothly and uniformly upon the drum. The guide is actuated by a double screw, with equal right and left pitches,

*This is on the assumption that the rope travels on a radius due to that of the gypsy head plus its own radius, which has been proved by the passage of the same wire over our register sheave.

similar to that employed on the distributing roller of the Adams printing press; this screw reverses the direction of the guide when it reaches the end of the thread, and the pitch of that thread is equal to the diameter of the rope. It is geared to the drum by toothed gears of equal pitch diameters, one of which has a clutch coupling for disengaging. When paying out rope the guide is disengaged not only from the toothed gears, but also from the double screw, which leaves it free to travel by the pressure of the wire rope upon its sides.

The principal dimensions and the weight of the reeling engine and wire rope are as follow:

Diameter of the drum.....	inches..	16
Length of the drum	do.....	36
Width of the flanges.....	do.....	17
Ratio of the gearing		4 $\frac{2}{19}$:1
Number of steam cylinders.....		2
Diameter of the steam cylinders.....	inches..	7 $\frac{1}{2}$
Stroke of the pistons.....	do.....	8
Length of $\frac{3}{8}$ -inch diameter wire rope the reel will hold.....	fathoms..	4,500
Weight of the reeling engine.....	pounds..	3,500
Weight of the 4,500 fathoms of wire rope	do.....	5,940
Total weight of the engine and wire rope.....	do.....	9,440

The engine receives steam from the main boilers and exhausts it into the main condenser or into the atmosphere as desired.

The wire rope, after leaving the dredging engine, is passed under a governor, *a* (Plate XXV), then to a leading block forward of the engine, and finally back to the reeling engine. The object of the governor is to keep a tolerably uniform tension on the rope, compensating for the surging on the dredging engine, and at the same time accommodating the plane of its sheaves' rotation to the varying direction of the wire rope as it passes. This governor is the invention of Lieutenant-Commander Tauner, the writer being responsible for its proportions. It consists of a sheave revolving in a vertical plane, within a frame which moves on a horizontal axis; the pressure on the sheave being resisted by a spiral spring shown in Plate XXV. To augment the efficiency of the governor the writer added the bell-crank and rod (*b*) to operate a Watson & McDaniel pressure-regulating valve, instead of the throttle as was originally intended. By this simple arrangement the tension on the wire between the dredging engine and the reeling engine controls the motion of the latter. The pressure regulator is automatic, independently of the motion of the engine, and is, therefore, an additional safety; it is similar to the valve shown in Fig. 18, but has a lever and weight instead of a spring as shown in that figure.

SOUNDING ENGINE.

The sounding engine (Plate XXVII) was built by Copeland & Bacon, of New York, according to the design and safe patent of Mr. E. C. Bacon. It is a single-cylindere, vertical, half-trunk engine with a lo-

comotive slide valve, actuated by a rod and a pin in the end of the shaft. The cranks are cast-iron disks, one of which is scored to receive a round belt for driving the drum which carries the sounding wire.

The steam cylinder is $5\frac{1}{4}$ inches in diameter and the stroke of piston is 5 inches. The diameter of the driving wheel (or crank) measured to the center line of the round belt is 13 inches, and the diameter of the drum, measured in the same manner, is $24\frac{1}{8}$ inches. The power of the engine is ample and its design is simple. It exhausts into the main condenser, and the cylinder cocks have been piped to discharge into the exhaust passage.

The belt is unshipped when the sounding wire is being paid out, and must be shipped each time it is hove in, which occasions a little delay, but when this is finished and the cylinder clear of water, the engine hauls in the wire at the average rate of about 100 fathoms per minute. The speed of the engine is usually regulated to the tension on the wire as recorded by the dynamometer, the attendant keeping it as nearly as possible at 80 pounds, which is about 40 per cent of the maximum strength of the wire. .

THE STEAM WINDLASS.

This machine, shown in elevation in Plate XIV, is commercially known as the "No. 4, Providence capstan windlass," and was built by the American Ship Windlass Company. It is situated under the fore-castle on the main deck. The windlass portion consists of a horizontal wrought-iron shaft, mounted in journals on cast-iron frames, and carries two gypsy heads, *a a*, two cam-clutch wheels, *d d*, a bevel gear-wheel, and a spiral gear-wheel, which are keyed to the shaft; it also carries a pair of chain-holders, *b b*, and friction-breaks, *c c*, which are not keyed to the shaft. The bevel gear communicates motion to or from the capstan, and may be uncoupled by unkeying the pinion; the spiral gear is for communicating the motion of the engine to the windlass. By revolving the cam-wheels, *d d*, a fraction of a revolution they are coupled to the chain-holders, *b b*, by which means the chain-holders may be made to revolve with the shaft at pleasure, and by this means the chain may be veered to one anchor while the other is hoisted; both may be hoisted or both veered while the engine is in motion. The capstan is on the fore-castle deck and is keyed to the shaft or spindle *f*. This capstan, which is revolved through the bevel gears, is used for catting and fishing the anchors, for hauling upon hawsers, hoisting boats, &c.

The engines are placed horizontally beneath the fore-castle deck. They rotate in the same plane, are placed at an angle of 90° , and act upon the same crank-pin. They have locomotive slide valves actuated by "loose" eccentrics, by which means the engines are reversible. The cylinders and their respective cross-head guides are in one casting, while the outer cylinder heads only are movable. The cylinders are sufficiently large to hoist both anchors at ordinary depths of water,

with 10 or 12 pounds of steam per square inch of piston, and for this reason we placed a pressure-regulating valve (Fig. 18) in the steam-pipe; by tightening or slacking the screw we can adjust the steam in the cylinder to any pressure inside the limit of the boiler pressure.

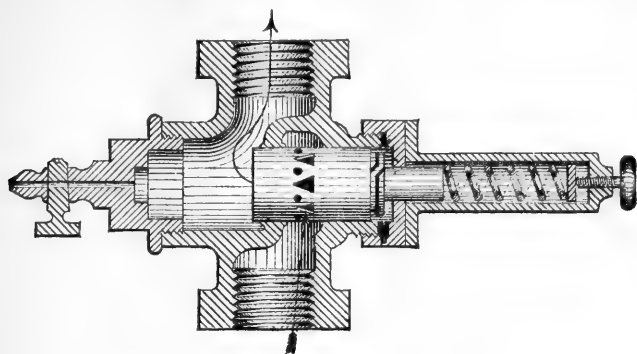


Fig. 18.

The engine takes its steam from the main boilers, and exhausts into the main condenser or into the atmosphere, as desired.

The principal dimensions of the steam windlass are as follow :

Diameter of the windlass shaft	inches..	3 $\frac{3}{4}$
Smallest diameter of the gipsy heads.....	do....	10 $\frac{1}{2}$
Largest (inboard) diameter of the gipsy heads.....	do....	15
End (outboard) diameter of the gipsy heads.....	do....	13 $\frac{1}{2}$
Length of the gipsy heads	do....	13 $\frac{1}{2}$
Number of whelps on the chain-holders .....	.....	5
Size of the starboard chain (diameter of iron)	inches..	1 $\frac{3}{8}$
Size of the port chain (diameter of iron)	do....	1 $\frac{3}{16}$
Chain per revolution of the starboard chain-holder	fathoms..	$\frac{3}{8}$
Chain per revolution of the port chain-holder	do....	$\frac{1}{17}$
Diameter of the friction-brakes	inches..	23
Width of face of the friction-brakes	do....	2 $\frac{1}{2}$
Total length of the windlass shaft	do....	92
Number of teeth in the bevel spur-wheel.....	do....	49
Number of teeth in the bevel pinion .....	.....	12
Number of teeth in the spiral gear-wheel .....	.....	52
Number of convolutions of the "worm" screw thread.....	.....	4
Outer diameter of the worm screw	inches..	8
Radial length of the worm-screw threads	do....	1 $\frac{1}{4}$
Pitch of the spiral gear.....	do....	1 $\frac{5}{8}$
Diameter of the capstan spindle	do....	3 $\frac{7}{16}$
Smallest diameter over the capstan whelps	do....	10 $\frac{3}{4}$
Projected height of the capstan drum	do....	14
Number of steam cylinders.....	.....	2
Diameter of the steam cylinders.....	inches..	8
Stroke of the pistons	do....	8
Diameter of the piston rods.....	do....	1 $\frac{3}{8}$
Diameter of the connecting rods at the neck	do....	1 $\frac{1}{2}$
Diameter of the crank pin	do....	2 $\frac{3}{4}$
Length of the crank-pin journal	do....	6

Diameter of the cross-head pins	inches..	2
Length of the cross-head pin journals	do....	2
Ordinary speed of the engine, in revolutions, per minute.....		300
Rate of heaving in the starboard anchor, in fathoms, per minute		4
Rate of heaving in the port anchor, in fathoms, per minute.....		3 $\frac{1}{4}$
Length of the starboard chain.....	fathoms..	120
Length of the port chain.....	do....	120
Weight of the starboard chain	pounds..	14,745
Weight of the port chain	do....	9,283
Weight of the starboard anchor and stock.....	do....	2,760
Weight of the port anchor and stock	do....	1,950
Total weight of both anchors and chains	do....	28,737
Weight of the steam capstan windlass, complete.....	do....	9,000

The engine makes from 275 to 325 revolutions per minute; at 300 revolutions the velocity of the starboard chain would be 4 fathoms per minute and the port chain three and four tenths (3.4) fathoms per minute.

STEAM STEERING GEAR.

The steam steering gear, known as the "steam quartermaster," was built by the Pusey & Jones Company according to the patents and design of Mr. Andrew Higginson, of Liverpool, England. The machine may be shifted from steam to hand power by the motion of a clutch, and the same wheel is used for steering by steam as by hand. Like other improved steam steerers the valve is arranged to reverse the engine by changing the ports, and an automatic arrangement is provided to bring the valve to its middle position (and stop the engine) by gearing from the engine itself.

There are three half-trunk, oscillating, single-acting steam cylinders arranged at angles of 120 degrees from each other, all acting on the same crank pin, after the "brotherhood" system. The cylinders are 4 $\frac{1}{4}$ inches diameter and 5-inches stroke of piston. On the crank shaft is a toothed pinion which gears into a spur-wheel; on the shaft of the spur-wheel is keyed a second pinion-wheel which gears into a second spur-wheel, making the ratio of gearing nearly 36. The second pinion and the second spur-wheel are keyed to hollow cast-iron shafts, through which the other two shafts, respectively, work.

Motion is communicated to the tiller chains by a chain-holder (or "wild-cat") similar to those used on patent windlasses. On the extended portion of the upper shaft there is a screw thread on which a large nut works; this nut is clutched to one of the pinions; on the forward end of the same shaft is placed the steering wheel, 5 feet 4 inches in diameter.

The motion of the steering wheel communicates like motion to the clutch-nut, which, in turn, imparts motion to the slide-valve of the engines; and the motion of the engines, transmitted through the gearing described, revolves the clutch-nut upon its thread in the opposite direction, and brings the valve back to its central position. By this contri-

vance the engine ceases its motion directly the helmsman brings his wheel to rest. The slide-valve, is common to the three cylinders; it is circular in form, and revolves upon its center by gearing from the steering wheel; its partitions or ribs divide it into three valves (one for each cylinder), though it is one casting. The exhaust is delivered into the steam-tight box which incloses the engine, and all the oil the crank-pin and crank-shaft journals ever receive must come with the steam worked through the cylinders. It cannot be hoped to keep the engine-box and main journal-boxes tight against air-leaks, and when the steering engine is exhausted into our main condenser we find a diminution of vacuum. The mechanical performance of the machine is all that can be desired. The engine starts the moment the wheel is moved and stops with equal promptness; the power of the machine is ample and it is comparatively light and compact. The toothed gears are rather noisy when steam is used.

D.—APPARATUS FOR DEEP-SEA RESEARCH.

Sigsbee's machine for sounding with wire is shown in Plate XXVII as in position on board the Albatross.

Nomenclature of the machine and its appointments.

- a. Cast-steel bed plate.
- b. Oak bed plate.
- c. Cast-steel frames for reel.
- d. Steel reel.
- e. Register.
- f. Guide frames.
- g. Cap.
- h. Accumulator-pulley.
- i. Accumulator-rope attached to pulley.
- j. Friction rope.
- k. Hinged frame.
- l. Cylinder of hoisting engine.
- m. Driving pulley.
- n. Ratchet crank.
- o. Tightening-pulley.
- p. Rope belt.
- q. Belt tightener.
- r. Flexible exhaust-hose.
- s. Flexible steam-hose.
- t. Strut.
- u u. Castors.
- v. Lewis bolt.
- w. Brace.
- xx. Guys.
- y. Guide pulley.
- z. Auxiliary brake.

The machine is placed on the port side of the topgallant forecandle, near the after end, and is rigged for reeling in.

The two bed plates *a* and *b* are firmly bolted together, the outboard end resting on a broad friction plate of brass (not shown in the sketch), one end of which is secured to the forecastle rail and the other supported by the strut *t*, which, by means of right and left hand screws on its ends, not only holds the friction plate in position, but regulates the height of the inboard end, so that the bed plate rests fairly on it at all times.

The friction plate has a groove along its center line through which passes a compressor bolt (not shown in the sketch), the upper end of which is secured to the bed plate, the lower end carrying a thread and nut. The inboard end of the machine is supported by a pair of brass castors, *u u*, arranged to conform to any direction in which it may be moved, and by simply tightening the compressor it is held in any desired position. For additional security when rigged out for use, a Lewis bolt, *v*, is set in the deck, through which a lashing may be passed to an eye-bolt on the bed plate.

The reel *d* is of steel strongly bolted; the sides are of boiler plate; the barrel is forged and welded; the hub is of cast iron, and the shaft of steel. The diameter of the reel is 22.89 inches, a turn of the wire equaling exactly one fathom, and it will hold about 6,000 fathoms of No. 11 music, 0.028 inch in diameter, the wire used in deep-sea sounding.

The friction ring, with the V-groove common to all sounding reels, is bolted to the right flange. The shaft carries a ratchet wheel on the left of the reel and a worm wheel on the right, into which the register *e* is geared.

The guide frames *f f* are hollow steel tubes, their bases screwed into the cast-steel hinged frame *k*, and their tops tied together by a steel casting which carries two pulleys, over which runs the accumulator-rope *i*. A neat copper cap *g* covers the apertures in the guide frames and protects the spiral accumulator springs inclosed within them.

The accumulator-pulley *h* is of brass, with brass guards over the upper half to prevent the wire from flying out of the score.

The frame is cast steel, having cross-heads working on guides bolted to the inner sides of the frames, with small grooved rollers at either end, the upper one for the accumulator-rope *i* and the other for the friction line *j*, the whole being very light in order to reduce its inertia to the minimum.

The spiral accumulator springs referred to above are 28½ inches long and 2½ inches outside diameter. They are made of No. 4 (American gauge) steel wire, and have an elastic limit of about 4 feet, with a weight of 150 pounds applied to the end of the wire, which will give the latter a cushioning of about 8 feet before it can be subjected to a violent jerking strain.

Graduated scales are so placed on the guide frames that the accumu-

lator springs act also as a dynamometer, showing at all times the strain on the wire.

The reeling engine *l* has its frame, which is of cast iron, in one piece bolted to the bed plate *a*. The cylinder is vertical (Copeland & Bacon's patent trunk) and $5\frac{1}{2}$ inches in diameter.

The driving pulley *m* has a V-groove corresponding to that on the reel over which the rope belt *p* is rove. The tightening-pulley *o* actuated by the belt tightener *q* gives the belt the desired tension.

The ratchet crank *n* is used in working water out of the cylinder and also, in starting, to assist the crank over the center.

Steam is received through the flexible hose connection *s*, and the exhaust is carried through a similar one *r*, both having brass connections flush with the forecastle deck.

The guide frames are held rigidly in position by the guys *x x* and the brace *w*. The guide pulley *y* is shown in position, and the grating hinged to the side for convenience in handling sinkers, &c., is shown in the sketch.

The machine being rigged and in place, to take a sounding, reeve the stray line over the accumulator-pulley and down through the fair-leader, bend on the sounding rod with sinker attached, reeve the friction line *j*, as shown in the sketch, bringing the standing part up over the V-groove on the reel and making it fast to its hook on the bed plate between the reel and the engine; the hauling part being led out under and abaft the reel where it is attended by the officer in charge or a careful man. The belt is, of course, thrown off when sounding. Everything being in readiness, the sinker is carefully lowered to the water's edge, either by means of the crank or friction line (the former being preferable), the small lead is bent to the stray line, the thermometer and water specimen cup are clamped on, the register is set at zero, and the vessel laid properly. The officer in charge takes his station on the grating outside of the machine, where he has a view of the wire at all times. A seaman is at the friction line; another, crank in hand, stands on the left; another at the brake *z*, on the right, also with a crank, and a fourth is on the grating outside to attend the guide pulley, handle sinkers, &c. A fireman is stationed at the engine. The record keeper takes a favorable position for reading the register, and the officer in charge gives the order, "Let go!" The friction line is then given a tension that allows the sinker to descend from 70 to 110 fathoms per minute, as may be considered prudent, the record keeper timing each 100 fathoms.

The officer in charge maneuvers the vessel to keep the wire vertical. The instant the sinker strikes bottom the reel is stopped by the friction line, assisted, if necessary, by the brake. The record keeper notes the number of turns indicated by the register, the cranks are shipped and sufficient wire hove in by hand to clear the bottom, when they are unshipped and laid one side; the belt is adjusted, steam admitted to the

cylinder, and the ratchet crank brought into requisition to assist in starting with a gentle motion. As soon as the engine works uniformly the speed is increased and the wire hove in at the rate of 100 to 150 fathoms per minute, each 100 fathoms being timed by the record keeper the same as when going out. The last 10 fathoms are reeled in by hand. The thermometer is read by the officer in charge and verified by the record keeper; the specimen cup of water is turned over to the medical officer, who either determines the specific gravity of the water or preserves it in specially prepared bottles to be sent to the laboratory at Washington for chemical analysis.

To secure the machine when not required for use, remove the register *c*, belt tightener *g*, ratchet crank *n*, and the steam and exhaust hose *s* and *r*, and stow them away. Unship the reel *d* and stow it in its tank, which contains sufficient sperm oil to cover the wire. Cast off the lashing *v*, loosen the compressor, and run the machine in; slacken the brace *w* and guys *x x*, and bring the head of the guide frames *ff* inboard until they are horizontal, when the after one will rest in a crutch on the engine frame. The frame *k* will then be in a vertical position, the guide pulley will be lowered between the guide frames *ff*, the accumulator pulley *h* unshipped, and the upper half of the guide frames turned back upon the lower portion, a double-hinged joint being provided for the purpose. The machine will then be turned fore and aft on the friction plate close to the forecastle rail, where it is held in position by the compressor. A painted canvas cover is drawn over all and secured under the bed plate to protect it from the weather.

The clamp is a cylindrical piece of lignum-vitæ about 6 inches in length by 4 in diameter, divided longitudinally through its center, and right and left hand screws introduced, by means of which the halves can be separated or brought together. It is used for holding the sounding wire, when, from any cause, it is necessary to slacken it between the reel and guide pulley. It is usually carried in an appropriate socket on the bed plate, ready for instant use.

Defective splices are usually discovered while reeling in, and the clamp is brought into requisition to hold the wire while a new splice is made. The machine had some defects when received from the maker, D. Ballauf, Washington, D. C., although the workmanship was performed in the best possible manner. The Sigsbee reel, weighing about 90 pounds, proved unequal to the crushing strain to which it was subjected in depths exceeding 2,000 fathoms. We then strengthened one, adding about 40 pounds in weight, which did good service in depths up to 3,000 fathoms, but finally collapsed. Two heavier reels, weighing 150 pounds each, were then constructed. Sigbee's general plan was followed, the extra material being placed where former reels had been deficient in strength. We have experienced no further trouble in that direction, and the increased weight is hardly noticed in practice.

The round leather belts furnished with the machine were useless, and

were replaced by round gutta-percha belts, which answered very well so long as kept away from the cylinder of the reeling engine. This, however, was difficult at times, and when they did accidentally touch it the gutta-percha would melt almost as quickly as tallow. The belt finally adopted is a simple grommet strap of 18 or 21 thread ratlin stuff which is quickly made on board ship, does its work well, and is very durable.

BELT TIGHTENER.

The tightening pulley was formerly adjusted by hand, requiring the united strength of two or three men; even then the belt would frequently slip. To remedy this evil the belt tightener (Plate XXVIII) was designed. I made a rough sketch of it, and Passed Assistant Engineer G. W. Baird, U. S. N., reduced it to the proper proportions, and superintended its construction. Fig. 1 shows a general view of the apparatus ready to be attached to the vertical shaft carrying the tightening pulley. This is done by placing it over the end and inserting the pin, Fig. 2, in a hole in the shaft, as shown in Plate XXVIII. By the use of this simple appliance the belt was promptly brought to the desired tension and our troubles in that direction ceased.

THE RATCHET CRANK (PLATE XXVIII).

The reeling engine having a single cylinder, it was found necessary in starting to open the throttle wide, and assist the crank over the center by hand, when it would start off at great speed, bringing undue strain on the wire. This difficulty was partially remedied by shipping the reel cranks and starting by hand, thus attaining the gentle motion desired. The only objection to this arrangement was the difficulty inexperienced men had in unshipping the cranks while the engine was in motion. A ratchet crank on one end of the crank shaft seemed to me the simplest and most direct remedy, as it would always be in position for instant use; and, instead of unshipping it when the engine was working, it would remain in place, hanging vertically as shown in Plate XXVII. I made a rough sketch, and gave it to Passed Assistant Engineer Baird, who reduced it to the proper proportions, made a working drawing, and superintended the making of the crank, which has performed its work admirably. Fig. 1 is a front, and Fig. 2 a side view of the ratchet crank.

TANNER'S SOUNDING MACHINE (PLATE XXIX).

This machine was designed for service on board the United States Fish Commission steamer Fish Hawk, where it was used in depths not exceeding 800 fathoms. It is used on board this vessel when working in 200 fathoms or less, and for navigational purposes (where it is very useful, being always in readiness for sounding).

It is mounted on the port rail forward of the fore-rigging.

NOMENCLATURE.

- a.* Spindle.
- b b.* Frame.
- c.* Arm.
- d d.* Reel.
- e.* Guide pulley.
- f.* Fair-leader.
- g g.* Cranks.
- h.* Register.
- i.* Pin.
- j.* Reel-tackle block.
- k.* Accumulator spring.
- l l.* Stray line.
- m.* Friction rope.
- n n.* Accumulator rope.
- o.* Eye for friction rope.
- p.* Socket.
- q.* Set screw.
- r.* Guide.
- s.* Lead.
- t.* Clamp.

The spindle is made of iron, turned, slightly tapering, and screwed firmly into the base of the frame *b b.* There is a brass bearing on the rail through which the spindle passes, the lower end resting in the socket *p.* The set screw *q* holds the machine in any desired position.

The frame above mentioned is of brass, cast in one piece, is bored to receive the reel shaft, and has appropriate lugs for the pawl and register. The reel *d d* is of cast brass, 22.89 inches in diameter, the initial turns of wire equaling 1 fathom, increasing as the score is filled, its capacity being about 2,000 fathoms.

The **V** friction groove, common to all sounding reels, is on the right flange, and is part of the same casting.

The cranks *g g*, by which the reel is turned, have conical friction surfaces, which are brought into contact with similar surfaces on the ends of the reel shaft by moving the right crank one-half a revolution ahead, the left one remaining clamped at *t*, or held firmly in the hand. The reverse motion releases the reel, allowing it to revolve freely without moving the cranks.

On the left side, between the frame and crank, is a worm wheel which operates the register. The ratchet and pawl are shown on the right, between the frame and crank.

The arm *c*, which supports the guide pulley *e*, is of iron, hinged between lugs on the frame, and held in position by the pin *i.* The small metal reel-tackle block *j*, projecting from the arm, is part of a tackle for suspending the reel when mounting or dismounting.

The guide pulley *e* is of brass, with a **V** groove, the upper portion being covered with a guard to prevent the wire from flying off. The pulley is hung on a frame, having a spindle extending into the metal casing above, the small arm *k* being confined to its upper end by a nut.

A spiral accumulator spring surrounds the spindle, and is compressed by the weight of the lead *s*, giving the guide pulley *e* a vertical play of about 3 inches. The fair-leader *f* swings freely in and out, but is rigid laterally, and guides the wire fairly into the score of the pulley. The aperture through which the wire passes is lined with highly tempered steel.

The standing part of the friction rope *m* hooks to the eye *o* in the frame, is carried around the reel in the **V** groove, and the free end is secured to the bight of the accumulator rope *n n* at *m*; one part being hooked to the small arm *k*, and the other made fast to the arm *c*, for the purpose of supporting the friction rope when it is slack and preventing its flying out of the **V** groove. The guide *r* leads the wire fairly on the reel. The machine revolves freely, its weight being sustained by the socket *p*. The set screw *q* holds it in position."

To take a sounding, the wire being on the reel and the latter mounted, haul the friction rope hand-taut before the lead is attached, and while the guide pulley is up in place. In this position it requires a strong man to move the reel, but the lead being bent and suspended, it compresses the accumulator spring, and drags the pulley down sufficiently to slack the friction rope and allow the reel to revolve with comparative freedom. The instant the lead strikes the bottom, however, or the weight is removed from any cause, the pulley flies up, putting a tension on the friction rope, which instantly checks the reel.

The friction rope being properly adjusted, reeve the stray line over the guide pulley and bend on the lead. Throw the pawl out of action, attend the friction rope, and lower the lead to the water; set the register at zero, and take the cast, governing the speed of descent by means of the friction rope, which is grasped by the right hand at *m*. As soon as the lead reaches bottom, bring the cranks into action by turning the right one a half turn ahead, read the register, unclamp the left crank at *t*, throw the pawl into action and heave in. When the lead is up, clamp the left crank at *t*, move the right one a half turn back, thus throwing them out of action, and the machine is ready for another cast.

If there is much sea running, it is necessary to use a light lead attached to the upper end of the stray line to prevent kinking the wire when slackened by the vessel's pitching.

To dismount the reel reeve the tackle *j* and take the weight off the reel; remove the nut on the left or after end of the reel shaft, grasp the ratchet wheel with both hands, and withdraw the shaft and right crank, leaving the left crank and worm wheel in position; swing the reel clear and lower it on deck, returning the shaft and crank to their place. If the frame is to remain on the rail, remove the register, withdraw the pin *i*, and bring the arm and guide pulley down to the frame *b b*, turn the machine inboard, and tighten the set screw to hold it in position.

To wholly dismount the machine for transportation or storage, remove

the reel, cranks, and register, disconnect the arm at *i*, and unscrew the spindle from the frame. The total weight is 135 pounds.

In sounding with wire it is absolutely necessary to keep it taut, slack wire always kinks, and a kink is followed by a break. It is also liable, when slackened, to fly off the reel.

If the ordinary sounding wire (No. 11 music, Washburn and Moen) is used, it is necessary to protect it by keeping the reel in oil when not in use; but with a view to having the machine ready for service at all times, we substitute No. 21 wire, and allow it to remain on the reel without other protection than an occasional oiling. It rusts as a matter of course, but we find by experience that it lasts from six to eight months.

It is hardly necessary to observe that this heavy wire is practicable in depths of a few hundred fathoms only.

The machine is protected from the weather by a painted canvas cover.

PIANO-FORTE WIRE FOR SOUNDING.

The piano wire used for sounding by the vessels of the United States Fish Commission is made by the Washburn & Moen Manufacturing Company, of Worcester, Mass., and is called by them No. 11 music. It is 0.028 of an inch in diameter, corresponding to No. 21 American and No. 22 Birmingham gauge. It is furnished by the manufacturers in sealed tin cans containing 50 pounds each, or about 3,850 fathoms in six coils $8\frac{1}{2}$ inches in diameter, containing about 640 fathoms in two lengths.

The coils are double, wrapped with heavy paper, a liberal sprinkling of whiting being inclosed with the wire. It is practically indestructible as long as it remains in the sealed can, and if put in a dry place will keep well in the paper wrapping after it is removed from the can. We have never lost a fathom of American wire from rust in the coil. It is highly polished and resists rust remarkably well when in use. Its weight is 1.3 pounds per 100 fathoms in air and 1.13 pounds in sea water. Its tensile strength is quite uniform, the mean of several tests giving the breaking strain 207 pounds. The cost is \$1.50 per pound.

We have also used English wire from Messrs. Webster & Horsfall, Birmingham, England, of the same size, No. 22 Birmingham gauge (0.028 inch diameter), corresponding to No. 21 American gauge or No. 11 music.

The tensile strength from the mean of several tests was 214 pounds, practically the same as the American wire. The cost is 75 cents per pound.

It possesses certain disadvantages, however, for use on board ship, which tend to counteract the advantages derived from its cheapness at first cost. It is received from the makers in 18-inch coils, made up of pieces from 100 to 400 fathoms in length, the coils weighing about 60

pounds each. They are wrapped in oiled paper, which is liable to be torn in handling, exposing the wire to the sea air, when it is soon ruined by rust. The losses from this cause prove at times quite serious. When this wire is used for sounding it is advisable to put the whole supply on reels of some sort and place them in oil at once, where it will remain free from rust until it is required for use.

This wire is less highly polished than the American and for this reason rusts more quickly, requiring greater care when in use.

METHODS OF SPLICING WIRE.

The following simple and effective method was formerly used with good results, and, although no longer followed, it is worthy of mention. Clean the ends of the wire thoroughly for two feet and lay them together with about eight turns; wind the ends and two intermediate points with a few turns of very fine annealed wire; cover them with solder and smooth the surface with knife and sand paper.

MAY'S SPLICE (PLATE XXX).

Lieut. Sidney H. May, U. S. N., had general charge of the sounding apparatus during our first year's work, and among many useful suggestions was the wire splice above mentioned, which was used with such excellent results that we finally adopted it in preference to all others.

The ends are filed to a long tapering point, and thoroughly cleaned for about a foot, then laid together with four turns and a seizing of very small annealed wire put on near each end (Fig. 2). The tapered ends, which have become annealed during the filing process, are wrapped closely around the standing parts, and the whole splice is covered with solder by running it back and forth through a groove in a piece of board, in which a small quantity of solder is kept in a fluid state by the application of a soldering iron. It is smoothed down with knife, file, and sand paper. Fig. 3 shows the splice partially covered with solder, and Fig. 4 the completed splice; the total length of which is from 6 to 7 inches.

The ends are quickly tapered by grasping the wire with nippers or a small hand-vise, and laying it on a plane hard-wood surface for filing.

SPIRIT LAMP FOR SOLDERING SPLICES OF SOUNDING WIRE (PLATE XXXI).

The soldering iron has been partially superseded by the spirit lamp for soldering sounding wire. A quantity of solder is placed in the cup over the flame, where it is soon melted. The wire having been prepared as directed, is drawn back and forth through the fused metal until a sufficient quantity adheres, when the splice is smoothed in the usual manner,

METHOD OF SPLICING WIRE TO STRAY LINE (PLATE XXX).

In sounding with wire it is necessary to have a flexible cord between the sinker and wire to take up any slack that may occur when the former strikes the bottom. This cord is known as stray line, Fig. 5; cod line is used for the purpose, and is attached to the wire in the following manner: The wire is stuck twice against the lay 5 inches from the end of the stray line, then passed with the lay from 4 to 6 inches, the end stuck twice against the lay, and served over with sail twine. The wire is then passed with the lay to the end of the line, the strands trimmed down and served over with twine, and a seizing is also put on over the wire first stuck against the lay. This makes a neat and secure splice, which passes readily over the accumulator pulley without danger of catching on the guards or fair-leader.

THE MEASURING REEL (PLATE XXXII).

The service reel being 22.89 inches in diameter, the initial layer of wire, 0.028 inch in diameter, equals one fathom to the turn, the next layer a trifle more and so on, until with a full reel the error would be about 10 inches to the turn; and as the register indicates the turns only, a correction must be applied to its reading. In order to determine the amount of error, the wire is measured as it is wound on the service reel by means of the measuring reel, which is made of cast iron, is 22.89 inches in diameter, and mounted in a cast-steel frame bolted to a heavy oak bed plate. On the reel shaft between the reel and frame is a worm wheel which actuates the register.

THE BLADE (PLATE XXXII).

The blade is used in connection with the measuring reel for transferring wire from the coil to the service reel. Fig. 1 is a longitudinal sectional elevation showing the method of construction. It is made of oak with the following exceptions: an iron screw and washer at the top of the spindle, which supports the reel; a galvanized iron washer, which is placed on the reel over the coil of wire to prevent slack turns from flying off; and a galvanized iron rim around the base of the reel to confine slack turns that might fall between it and the bed. Fig. 2 shows the reel ready for service.

TRANSFERRING AND MEASURING WIRE.

The service reel is mounted on the Sigsbee sounding machine, which is set at any desired angle with the deck; the hand cranks and register are shipped, and the reel carefully cleaned and oiled.

The measuring reel is placed directly in the rear of the sounding machine, and the blade in the rear of the reel and in line with both. The sealed tin can in which the wire is received is opened, a coil taken out,

removed from the paper, and placed on the blade; the wire stops are cut, the free end of the wire led out, and three turns taken around the measuring reel in such a manner that the register will count ahead during the transfer. The end is then taken to the service reel, and clinched through the hole provided for this purpose. The two men at the blade reel back the slack wire, the record keeper sets both registers at zero, and takes his station for reading the one on the measuring reel, the officer in charge watching that on the service reel. The cranks are manned and the transfer begins, the reel being turned at any desired speed. One of the men at the blade puts a slight tension on the wire by applying an old piece of canvas in his hand to the iron rim at the base of the reel.

The record keeper calls out "mark!" at every 50 fathoms registered by the measuring reel, the officer in charge reads the register on the service reel at the same instant, and this being recorded the difference between the two readings shows the error at that point. This process being carried on until the reel is filled, furnishes data from which a correction table is made, by which soundings can be corrected readily by inspection.

A correction table once made for a certain reel is always available for that reel, or any others of the same dimensions, provided the amount of wire on it is less than that for which the table was constructed.

Correction table.—Reel No. 1.

SIGSBEE'S DETACHER (PLATE XXXIII.)

[Used in connection with a modification of Captain Belknap's sounding cylinder No. 2.]

The first device for detaching the sinker and bringing up a specimen of the bottom in deep-sea sounding was the invention of Passed Midshipman John M. Brooke, U. S. N., about 1852-'53. It consisted of a small iron rod carrying a trigger at the upper end, and a small tube at the other extremity, in which several goose-quills were placed for bringing up bottom specimens. The sinkers were much like those of the present day, a shot with a hole through it.

To prepare for a sounding the line was bent to the trigger, the goose-quills were adjusted in the tube, the sounding rod was inserted in the hole through the sinker, the slings were passed under the sinker and hooked to the trigger, which sustained the weight until the sounding line was slackened by its striking the bottom, when the trigger capsized by its own weight, the slings slipped off and the sinker was released.

Sands' cup was the next device brought into use in the Navy and Coast Survey, but Brooke's apparatus was in general use until the "Hydra" machine as improved by Staff Commander Baillie, R. N., was adopted.

The Fitzgerald machine was used to some extent in the British navy.

The next marked improvement is due to Capt. Geo. E. Belknap, U. S. N., who while in command of the U. S. S. Tuscarora made the most remarkable series of deep-sea soundings on record. Following in his footsteps Lieut.-Comdr. C. D. Sigsbee, U. S. N., made some modifications in the Belknap cylinder, and added to it a detaching trigger of his own, reducing it to its present form as shown in the plate.

If the various types of sounding cylinders and detachers made since Brooke's invention became known were examined, it would be seen that they are all modifications of his system, as in sounding with wire all recent improvements in that direction have been modifications of Sir William Thompson's admirable system.

NOMENCLATURE.

- a.* Cylinder.
- b.* Screw joint.
- c c.* Upper and lower guide stem.
- d.* Cylindrical ring.
- e.* Valve seat.
- f.* Poppet valve.
- g.* Valve stem.
- h.* Spiral valve spring.
- i.* Hollow cone.
- j.* Perforated plate.
- k.* Swivel.
- l.* Pawl.
- m.* Tumbler.
- n.* Spring.
- p.* Apertures for escape of water.
- q.* Sinker.
- r.* Iron wire bail.

A longitudinal sectional elevation of Sigsbee's detacher and his modification of Captain Belknap's sounding cylinder No. 2 is shown in Fig. 1; a side view is seen in Fig. 2, with the sinker hung. Fig. 3 shows a plan view of the cylinder and a longitudinal sectional elevation of the detacher. Fig. 4 shows a back view of the detacher. The perforated plate *j* and cylindrical ring *d* are shown in Fig. 5, and an enlarged view of the hollow cone *i*, cylindrical ring *d*, apertures *p* for the escape of water, and the upper end of the cylinder *a* are shown in Fig. 6.

The cylinder *a* (Fig. 1) is attached rigidly to the guide stem *c*, the poppet valve *f* is on its seat at *ee*, and the hollow valve stem encircles the guide stem *c*, and is held in place by the spiral valve spring *h*. The hollow cone *i* moves freely on the upper guide stem; *dd* is a cylindrical ring forming the base of the cone *i*, and, when raised during the descent of the sinker, as in Fig. 1, it permits the water to flow freely from the cylinder through the apertures *pp* into the cone at *dd* and out at *pp*; but during the ascent it rests on the top of the cylinder *a*, closing the apertures (Fig. 6) against all outward pressure.

To take a sounding and bring up a specimen of the bottom, bend the stray line to the swivel *k*, slip the sinker on and hook the bail *r* on the tumbler *m*; lock the pawl and tumbler and suspend the weight of sinker and sounding rod from *k*, where it will remain until the weight is relieved by the sinker striking the bottom. The pawl will then assume a horizontal position from its own weight (Fig. 3); the tumbler will be thrown out of action by the spring *n*, assisted by its excess of weight at the point of contact with the bail *r*, thus releasing the sinker.

When the cylinder strikes the bottom, the valve *f* will be forced up, and more or less of the interior space of the cylinder will be filled with a specimen of the bottom soil. As soon as the ascent begins the valve *f* reseats itself, and, the apertures at the top being closed, the specimen is hermetically sealed. On reaching the surface it is removed by unscrewing the cylinder at *b*.

This apparatus has performed its work perfectly; in fact it has never failed to detach the sinker and bring up a specimen when the bottom was reached. They were furnished by D. Ballauf, Washington, D. C., at \$15 each.

SINKERS.

All soundings exceeding the capacity of an ordinary hand lead-line are made with wire; in depths of over 2,000 fathoms a 60-pound detachable sinker is used; between 1,000 and 2,000, a 35-pound sinker, also detachable; and from 500 to 1,000 fathoms, an ordinary 35-pound ship's lead is used and reeled back. In depths less than 500 fathoms lighter leads, from 18 to 25 pounds weight, are used and reeled back, the bottom specimen being brought up by the arming.

The detachable sinkers are made of cast iron and are furnished by the ordnance department, navy-yard, Washington, D. C., fitted and bailed ready for use.

SIGSBEE'S WATER-SPECIMEN CUP (PLATE XXXIV).

The Sigsbee water-specimen cup, or water bottle, is designed to bring a specimen of water from any desired depth for the purpose of analysis or to determine its specific gravity. The valves are closed mechanically and cannot be opened again, except by hand, therefore these cups may be used in series, any desired number being sent down on the same line.

NOMENCLATURE.

- a.* Cylinder.
- b.* Lower valve seat.
- c.* Detachable upper valve seat.
- d.* Upper poppet valve.
- e.* Lower poppet valve.
- f.* Valve stem.
- g.* German silver compression spring.
- h.* The frame
- i.* German silver removable sleeve.
- j.* Brass pin.
- k.* German silver shaft.
- l.* Screw thread (44 to the inch).
- m.* Screw thread (44 to the inch).
- n.* German silver propeller.
- o.* Hub.
- p.* Inside screw thread (44 to the inch).
- q.* Guide cap.
- r.* Beveled lugs.
- s.* German silver bushing.
- t.* German silver screw cap with milled head.
- u.* Beveled slots.
- v.* Inside screw thread.
- w.* Clamp lugs.
- x.* Clamp pivot screw.
- y.* Phosphor bronze clamp wire.

The water bottle is made of brass, except such parts as are mentioned as being made of other metals.

The following remarks upon its working are taken from Sigsbee's Deep-sea Sounding and Dredging:

"To adjust the valves hold the upper valve firmly, and unseat the lower valve by screwing it upward," the key (Fig. 5) being applied to the lower end of the valve stem *f* for the purpose. "Then maintaining the upper valve on its seat with the finger, or better by turning the screw cap down upon it, reseal the lower valve gently. In general it will be necessary to adjust the valve only after the cup has been taken apart for cleaning or other purposes.

"The cup when in use comes to the surface filled with water, the screw cap pressing upon the upper valve, thus securing both valves, and the propeller resting upon the screw cap. To remove the specimen from the cup first lift the propeller, and by giving it a few turns cause its threads to engage the screw threads on the shaft; then turn up the screw cap until it uncouples. With the cap in this condition the valves

may be lifted and the water discharged. When the screw cap is pressing upon the upper valve the threads inside the former are engaged with the threads of the shaft, but on screwing up the cap, when its lower thread clears the upper thread of the corresponding series on the shaft, the cap is uncoupled, which prevents any mistake being made at this point by the person handling the cup; afterwards the screw cap may be turned in the same direction indefinitely without jamming or changing its position on the shaft.

“With the screw cap up and the propeller in any position, the cup is automatic, and may, if desired, be lowered into the water with no other preparation; yet it is a good practice first to screw up the propeller by hand to observe if the threads are in perfect working order. Assuming the propeller to be low down on the shaft, or even resting upon the screw cap, the action of the water is as follows:

“As it descends, the valves are lifted and held up by the resistance of the water; by the same agency the propeller is revolved and carried upward until, like the screw cap, it is uncoupled, after which it revolves freely on the shaft, impinging against the German silver sleeve. If the propeller hub is allowed to come in contact with the sleeve while the screw threads are still engaged, it may remain impacted during the subsequent ascent. To insure uncoupling at the proper time the guide cap which fits over the top of the hub must be set well home in its position, when the propeller is fitted to its shaft. It will be noticed that the blades of the propeller are bent along their upper edges. With the blades thus bent, and all parts of the propeller made very light in weight, it has been found experimentally that the alternating movement of translation imparted to the submerged cup by the vessel's motion in a sea-way will cause the propeller, when engaged with the threads on the shaft, gradually to screw up rather than down. This shows that stoppages in the descent, whether to attach additional cups to the rope or wire, or for any purpose whatever, may be made with safety if the vessel is kept idle in the water, that is, without headway or sternboard. Were the blades not bent it is evident that the propeller would gradually screw down by the same alternating movement, since its weight would assist its action in screwing down, but resist the opposite motion. Even thus experiments have shown that with the alternating movement continued for a longer time than would probably be occupied by any stoppage, the propeller would screw down on the shaft only a small proportion of the distance to the screw cap. It is plain that in the event of such action the propeller would rise and uncouple each time the descent was continued. However, the bending of the blades insures safety, and the valves are left free to open during the whole descent. At any stoppage in the descent each cup contains within its cylinder a specimen of the water from its locality at the time being, allowing a margin of 1 or 2 feet.

“As soon as the ascent is begun the valves of each cup are pressed

firmly on their seats by the resistance of the water, and each propeller begins to screw down along its shaft under the same influence. When the upper thread inside the hub of the propeller clears the lower corresponding thread on the shaft the propeller uncouples, and drops upon the screw cap, which it clutches. The screw cap is then carried down until it comes in contact with the upper valve, from which position it cannot be removed by the action of the water or of the propeller. Both valves being thus locked, stoppages may be made thereafter during the ascent without risking the identity of the inclosed specimen of water.

"The distance through which the cup must pass, in order that the propeller may traverse the shaft and lock the valves, may be varied by altering the pitch of the propeller. As shown in the drawing the propeller would probably not perform its work short of 50 fathoms. I settled on about 25 fathoms as the distance most convenient. With this distance it would not be prudent to require the uppermost cup to bring a specimen from nearer the surface than 50 fathoms. If the propellers were arranged to lock the valve in an ascent of about 25 fathoms, and the uppermost cup were lowered only to a depth of 10 fathoms, for instance, obviously, when that cup had arrived at the height of the vessel's deck, the submerged cups, having passed through a distance of only about 12 fathoms, would not have become locked. Each cup, as soon as discharged, should be thoroughly rinsed in fresh water."

We have found these bottles to work satisfactorily for the purpose of collecting water specimens for specific gravity determinations; but they will not retain the gases, and are therefore not available for collecting specimens for chemical analysis.

Experience has taught us that it is advisable to reset the valves whenever the bottles are to be used, as their adjustment is liable to be impaired in releasing the screw cap from contact with the upper valve. Although Sigsbee states in the remarks quoted that the upper valve seat is detachable for purposes of cleaning, we find in practice that the accumulation of verdigris on the screw threads makes its safe removal impracticable. The valves and valve seats can be readily cleaned, however, without detaching the upper valve seat.

IMPROVED WATER BOTTLE.

The improved water bottle, Plates XXXV, XXXVI, and XXXVII, is designed to bring up a specimen of water from any desired depth, retaining the free gases for the purpose of analysis. The valves close mechanically and cannot be opened again except by hand; therefore it may, like the Sigsbee water specimen cup, be used in series, either with others of the same kind or with any instrument that can be used in series.

NOMENCLATURE.

- a*. Cylinder.
- b b*. Frame.
- c c*. Clamps to secure apparatus to temperature rope.
- d*. Expansion chamber.
- e*. Cock.
- f f*. Guards.
- g g*. Propellers.
- h h*. Shafts.
- i i*. Sleeves.
- j j*. Guys.
- k k*. Slots.
- l l*. Valves.
- m m*. Valve seats.
- n n*. End pieces.
- o o*. Spanner holes.
- p p*. Spanner holes.
- q q*. Set screws.
- r r r*. Stay rods.
- s s*. Inner arms of propeller frames.
- t t*. Outer arms of propeller frames.
- u u*. Cylinder clamp.
- v v*. Pin for cylinder clamp.

All parts of this water bottle are of brass, except the propeller blades, which are of German silver. The cylinder is a tube of commercial pattern; the frames, valves, valve seats, &c., are cast brass.

PREPARATION FOR USE (PLATE XXXVI).

Cleanse the inside of the cylinder from all foreign substances, particularly verdigris, oil, or red lead, which is sometimes used for making joints. Clean the valve faces and valve seats with a soft cloth, avoiding brick-dust, emery paper, or other scouring substances; as the valves are very carefully ground in and any scratch on their faces renders them liable to leak.

The valve seats should be removed for cleaning and replaced again, using spanners in the holes *o p* for the purpose, and to insure tight joints without undue strain a little red lead may be used on the shoulder between *m* and *n*.

In cleaning the cylinder particular attention should be given to the cock *e* and the expansion chamber *d*.

The propellers should be examined to see that they work freely on the sleeves and the supporting screws on their outer extremities. The shafts should be run up and down by means of the milled heads at *k*, to ascertain if the screw threads work freely and the shafts move on their bearings without undue friction.

The propellers should then be moved outward until they clear the supporting screws, where they will revolve freely during the descent without moving the shafts or in any way affecting the valves. The shafts should then be screwed inward a little to allow free connection with the valve stems *l*.

The cylinder may now be placed in the frames *b*, the valve stems *l* connected with the shafts *h*, and the cylinder secured in place by the clamps *u* and the pins *r* (Plate XXXVII). The valves should then be opened inwards to their full extent by means of the milled head at *k*. Secure the bottle to the rope by the clamps *c* (Plate XXXV), with the expansion chamber pointing upwards, and it will be in readiness for use.

TO OBTAIN A SPECIMEN OF WATER.

The dredge rope is used, having a sinker weighing 150 pounds. The apparatus being clamped to the rope a few fathoms above the sinker, lower away as rapidly as desired to the intended depth, and in case of temperature instruments not having been sent down, reel in at once.

The propellers now being brought into action soon close the valves.

The internal pressure which takes place as the apparatus ascends is relieved by the expansion chamber *d*. As soon as the bottle reaches the surface the valves are keyed to their seats through slots in the valve stems *l*. The cylinder is then removed from the frame and stowed in some cool place in a vertical position until such time as it can be delivered to the laboratory.

A vertical position is recommended in order to retain water on both sides of the piston in the expansion chamber to avoid possible drying and shrinkage of the packing.

TAKING CARE OF THE BOTTLE.

The water specimen having been procured and the cylinder removed, rinse the frame in fresh water and wipe it dry. Remove the set screws *g* and the shafts *h*, wipe them dry, and put a little oil on the screw threads.

Unscrew the sleeves *i* from the hubs of the propellers, wipe them dry inside and out, and oil them; wipe the propellers dry also and oil the inside of the hubs. Oil should be used sparingly, taking care that it does not drip into the cylinder.

Having cleaned and oiled the parts put them together and stow the frame in its packing box, which should be kept in a dry place.

As soon as the specimen has been removed from the bottle the latter should be rinsed in fresh water, the valve seats unscrewed, and the cylinder with its attachments carefully cleaned and dried as directed in its preparation for use. After the parts are put together clamp the bottle in the frame. Oil should never be used on the cylinder or its attachments.

ORIGIN OF THE IMPROVED WATER BOTTLE.

This water bottle as figured is the joint production of Dr. J. H. Kidder, of the United States Fish Commission; Surgeon J. M. Flint, United States Navy, attached to the United States Fish Commission steamer *Albatross*; and the writer.

It will be readily observed that it is a modification of the Sigsbee water specimen cup. The latter is well adapted for its purpose of collecting water specimens for specific gravities, but it will not retain the free gases in water intended for chemical analysis. Feeling the want of a bottle that would accomplish this desired end, Drs. Kidder and Flint devised one during the summer of 1884, which was made by D. Ballauf, of Washington, D. C., and sent to the Albatross for trial, and, after testing it, a few improvements suggested themselves to the writer and are embodied in the bottle figured.

We consider this bottle still in the experimental stage, although it has been very carefully constructed and has successfully withstood a pressure of 150 pounds per square inch. It is a well-known fact, however, that mechanism does not work as well under water as in the atmosphere, yet we anticipate good results from the apparatus in its present form.

THE NEGRETTI & ZAMBRA DEEP-SEA THERMOMETER.

The following description of this thermometer is copied, in part, from the catalogue of Negretti & Zambra, various eliminations and additions being made by the writer.

The construction of this thermometer will be readily understood by referring to Plate XXXVIII, Fig. 2, where it is shown in a vertical sectional elevation of Tanner's improved deep-sea thermometer case.

The thermometrical fluid is mercury; the bulb containing it is cylindrical, contracted in a peculiar manner at the neck *a*; and upon the shape and fairness of this contraction the success of the instrument mainly depends. Beyond *a* the tube is bent and a small catch reservoir at *b* is formed for a purpose to be presently explained. At the end of the tube a small receptacle *c* is provided. When the bulb is downward the glass contains sufficient mercury to fill the bulb, tube, and a part of the receptacle *c*, leaving, if the temperature is high, sufficient space in *c*. When the thermometer is held bulb upward the mercury breaks at *a*, but by its own weight flows down the tube filling *c* and a portion of the tube above *c*, depending upon the existing temperature. The scale is accordingly made to be read upward from *c*.

To set the instrument for observation it is only necessary to place it bulb downward, when the mercury takes the temperature just as in an ordinary thermometer. If at any time or place the temperature is required, all that has to be done is to turn the thermometer bulb upward and keep it in this position until the reading is taken. This may be done at any time afterward, for the quantity of mercury in the lower part of the tube which gives the reading is too small to be sensibly affected by a change of temperature, unless it is very great; while that in the bulb will continue to contract with greater cold and to expand with greater heat. In the latter case some mercury will pass the contraction *a* and may fall down and lodge at *b*, but it cannot go

further so long as the bulb is upward, and thus the temperature to be read will not be affected.

Now, whenever the thermometer can be handled it can readily be turned bulb upward for reading the existing temperature. It must be clearly understood that this thermometer is only intended to give the temperature at the time and place where it is turned over; it is simply a recording thermometer. In its present state it cannot be used as a self-registering maximum and minimum, though, if required, it could be constructed to act as a maximum.

In order to make the thermometer perfectly satisfactory, it was necessary to protect it from pressure as well in shallow as in the deepest seas, for in either case the pressure would cause an error of greater or less degree in its indications. Like an ordinary thermometer it is devoid of air, and so quite different from Sixe's, which, containing compressed air, has a certain internal resistance. Hence it would be more affected by pressure than Sixe's thermometer, however thick the glass of the bulb. By the simple expedient of inclosing the thermometer in a glass shield, *e*, hermetically sealed, the effect of external pressure is entirely eliminated. The shield must of course be strong, but not exhausted of air. It will, however, render the inclosed thermometer less readily affected by changes of temperature, making it more sluggish.

To counteract this tendency mercury is introduced into that portion of the shield surrounding the bulb, and confined there by a partition, *d*, cemented in the shield around the neck of the thermometer bulb. This mercury acts as a carrier of heat between the exterior of the shield and the interior of the thermometer; and the efficacy of this arrangement having been experimentally determined, the instrument has been found far superior in sensibility to Sixe's.

So long as the shield withstands the pressure—that is, does not break—the thermometer will be unaffected by pressure, and there is abundant experience to show that such a shield will stand the pressure of the deepest ocean. Doubtless the shield will be slightly compressed under great pressure, but this can never cause an internal pressure sufficient to have an appreciable effect upon the thermometer. This method of shielding is, therefore, quite efficacious, and deep-sea thermometers so protected do not require to be tested for pressure in the hydraulic press. They simply require accurate tests for sensitiveness and for errors of graduation, because they are standard instruments adapted to the determination of very small as well as great differences in temperature, some one or two tenths of a degree in shallow water. The test for sensitiveness should determine the time the instrument requires to take up a change of 5° , rise or fall, and the time is found to be from five to ten seconds.

Thus, provided the turning-over gear is found to answer, this instrument evidently possesses great advantages. It has no attached scale, the figures and graduations being distinctly marked on the stem itself,

and the shield effectually preserves them from obliteration. The part of the stem which forms the background to the graduations is enameled white to give distinctness to the mercury.

To make this instrument available for deep-sea use it is necessary to provide some reliable method of turning the bulb upward at the proper time; also, to prevent it from turning down again before the surface is reached and the temperature read.

Plate XXXVIII shows a metal frame devised by Commander Magnaghi of the Italian navy. It is described as follows in an advertisement of Messrs. Negretti & Zambra:

NEGRETTE & ZAMBRA'S PATENT IMPROVED FRAME STANDARD DEEP-SEA THERMOMETER.

"The apparatus will be best understood, short of inspection, by reference to Plate XXXVIII, Figs. 1 and 2. A is a metallic frame in which the case B containing the thermometer is pivoted upon an axis H, but not balanced upon it. C is a screw-fan attached to a spindle, one end of which works in a socket D, and on the other end is formed the thread of a screw E, about half an inch long, and just above it is a small pin or stop, F, on the spindle. G is a sliding top-piece against which the pin F impinges when the thermometer is adjusted for use. The screw E works into the end of the case B, the length of play to which it is adjusted. The number of turns of the screw into the case is regulated by means of the pin and stop-piece. The thermometer in its case is held in position by the screw E and descends into the sea in this position (Fig. 1), the fan C not acting during the descent because it is checked by the stop F. When the ascent commences the fan revolves, raises the screw E, and releases the thermometer which then turns over and registers the temperature of that spot, owing to the axis H being below the center of gravity of the case B as adjusted for the descent. Each revolution of the fan represents about 2 feet of movement through the water, so that the whole play of the screw requires 70 or 80 feet ascent; therefore, the space through which the thermometer should pass before turning over must be regulated at starting. If the instrument ascends a few feet by reason of a stoppage of the line while attaching other thermometers, or through the heave of the sea, or any cause whatever, the subsequent descent will cause the fan to carry back the stop to its initial position, and such stoppages may occur any number of times provided the line is not made to ascend through the space necessary to cause the fan to release the thermometer.

When the hauling in has caused the turn-over of the thermometer the lateral spring K forces the spring L into a slot in the case B and clamps it (Fig. 2) until it is received on board, so that no change of position can occur in the rest of the ascent from any cause.

The case B is cut open to expose the scale of the thermometer, and is also perforated to allow free entry of the water."

The thermometer (Fig. 3) has already been described.

The Magnaghi frame above described is a great improvement on the wooden cases formerly furnished by the makers, but even this did not prove entirely satisfactory in all respects, inasmuch as it could not be secured to sounding wire, and could not, therefore, be used in series. The fan failed to act occasionally, and the springs K and L were apt to hold the case B in a vertical position by friction, thus preventing the turn-over at the proper time.

Various devices have been used on the vessels of the commission for capsizing the thermometer; the Tanner case and the Bailie-Tanner case, described in former reports, were, however, the most successful. They were used with good results until the peculiar service of the Albatross demonstrated the necessity for some arrangement by which the thermometers could be used in series either on the sounding wire or the dredge rope, which is frequently used as a temperature rope. It was desirable also to reduce the weight and resistance as much as possible. We were troubled occasionally by the mercury shaking down from the catch reservoir into the tube, thus vitiating the reading. This was the result of jars of one kind or another. The speed of 600 to 800 feet per minute at which the sounding wire was hove in by steam was a fruitful source of trouble, causing great vibration, which was complicated by the jars incident to the rapid passing of centers by the single cylinder reeling engine. These difficulties were subsequently overcome in the manner hereafter described.

THE TANNER IMPROVED THERMOMETER CASE WITH THE SIGSBEE CLAMP, USED WITH THE NEGRETTI-ZAMBRA DEEP-SEA THERMOMETER (PLATE XXXIX).

Fig. 1 shows the apparatus complete, and Fig. 2 a vertical sectional elevation of the metal case containing the thermometer.

NOMENCLATURE.

- a.* Neck of the bulb.
- b.* Catch reservoir.
- c.* Small receptacle.
- d.* Partition confining mercury in shield surrounding bulb.
- e.* Glass shield inclosing thermometer.
- f.* Thermometer case.
- g.* Thimble with rubber lining.
- h.* Spiral springs.
- i.* Cap.
- j.* Pivot.
- k.* Slot for reading scale.
- l.* Frame of cast brass.
- m.* Guard.
- n.* Propeller.
- o.* Spindle.
- p.* Set screw.
- q.* Sigsbee clamp.

The entire apparatus is made of brass except the Sigsbee clamp, which is of phosphor bronze, and the rubber linings of the thimbles *g*.

To mount the thermometer unscrew the cap *i*, drop a spring *h* into the case, slip a thimble *g* over the glass shield at *d*, put the thermometer in the case, drop in another thimble, which will rest on the upper end of the shield, then place another spring on the thimble and screw the cap in place. The thermometer will then be suspended between delicate spiral springs at the ends and soft rubber rings which surround the shield. This arrangement has proved effectual in guarding the thermometer against jars incident to the service required of it on board of the Albatross.

To take a temperature set the spindle *o* into the hole in the cap *i* by screwing it down until the propeller blades strike the set screw *p*; then by means of the Sigsbee clamp *q* secure it to the temperature rope. The bulb will then be down and the mercury in the tube connected with it, the position required to take the temperature. The water acting on the propeller during the descent will keep it in position resting against the set screw *p*, but as soon as the reeling in begins the propeller is set in motion, bringing the screw on the upper end of the spindle into action, gradually raising the propeller until the lower end of the spindle is withdrawn from the hole in the cap *i*, when the thermometer promptly turns over and registers the temperature by breaking the column of mercury at the point *a*, the column then falling to the bottom of the tube.

It can be read at any time afterward, as changes of temperature do not affect the reading after the column is once broken.

The apparatus described above is simple and reliable.

THERMOMETERS FOR AIR AND SURFACE TEMPERATURES.

These thermometers are made by J. & H. J. Green, New York. The tubes are 10 inches in length, extra strong, and the scales are distinctly marked on them. Two-tenths of a degree is the greatest error found in testing them.

THE MILLER-CASELLA DEEP-SEA THERMOMETER.

Plate XL shows this thermometer in the copper case used for deep-sea work; also partially dismounted to show the form of construction. The magnet seen between the two instruments is used to adjust the indices.

The following description is from Sigsbee's Deep-sea Sounding and Dredging:

"A glass tube bent in the form of **U** is fastened to the vulcanite frame, and to the latter are secured white glass plates containing the graduated scales. Each limb of the tube terminates in a bulb. A column of mercury occupies the bend and a part of the capillary tube of each limb.

The large bulb and its corresponding limb above the mercury are

wholly filled with a mixture of creosote and water; the opposite limb above the mercury is partially filled with the same mixture, the remaining space therein being occupied by compressed air. In the mixture, on each side, is a steel index having a horse-hair tied around it near the upper extremity. The ends of the elastic horse-hair, being held in a pendant position by the inner walls of the tube, exert enough pressure to oppose a frictional resistance to a movement of the index in elevation or depression. As thus described, the instrument is a self-registering maximum and minimum thermometer for ordinary use. The indications are given by the expansion and contraction of the creosote and water mixture in the large full bulb.

"The instrument is set by bringing the lower end of the indices in contact with the mercury by means of a magnet provided for the purpose. Then, when the instrument is submitted to a higher temperature, the expansion of the mixture in the large bulb depresses the column of mercury on that side, and correspondingly elevates it on the other side. A decrease of temperature contracts the mixture in the large bulb, and by the elastic force of the compressed air in the smaller bulb, a transference of the column of mercury takes place in precisely the reverse manner to that which occurs on a rising temperature. Thus the mercury rises in the left limb for a lower, and in the right limb for a higher, temperature. The greater the change of temperature the higher the point reached in the respective limbs; hence the scale on the left is graduated from the top downwards, and that on the right from the bottom upwards. The rising of the mercury in either limb carries with it the index of that limb, and on the retreat of the mercury the index remains at the highest point attained. The bottom of the index, being the part which has been in contact with the mercury, gives the point at which to take the reading."

The large bulb of this thermometer is now protected from pressure by a glass shield which surrounds it; the space between the shield and bulb is nearly filled with alcohol, which acts as a transmitting medium for temperature performing the same function as the mercury in the shield of the Negretti & Zambra thermometer. The shield above mentioned has added much to the value of the instrument, as it has practically eliminated errors arising from varying pressures. This thermometer has been considered the standard for deep-sea work, and when several were to be sent down to great depths on the same line it was unrivaled until the present improvements in the methods of capsizing the Negretti & Zambra thermometers were introduced.

It is not as sensitive as the Negretti & Zambra, but under the above conditions a delay of a few minutes is not of great importance. The movable indices are a fruitful source of annoyance and vexatious delay. An index may, without an apparent cause, absolutely refuse to move in the tube; coaxing with the magnet is followed by lightly tapping the

frame in the hand or swinging it rapidly about the head; and if this fails more vigorous tapping is apt to follow with various active measures, none of which tend to improve the general condition of the instrument.

The indices are also liable to move if the instrument is subjected to rough treatment, although this is not of frequent occurrence with careful handling. Most of the minor casualties to which the instrument is liable are apparent to the eye and are readily adjusted.

WATER DENSITIES.

Hilgard's ocean salinometer (Plate XLI) is used on board of the Albatross for observing the density of sea-water.

An excellent description of the apparatus is given by Prof. J. E. Hilgard in the United States Coast Survey Report for 1874, and reproduced in Sigsbee's Deep-sea Sounding and Dredging, as follows:

"The density of sea-water in different latitudes and at different depths is an element of so great importance in the study of ocean physics as to have caused a great deal of attention to be paid lately to its determination. The instruments employed for the purpose have been, almost without exception, areometers of various forms. The differences of density as arising from saltness are so small that it is necessary to have a very sensitive instrument. As the density of ocean water at the temperature of 60° Fahr. only varies between the limits 1.024 and 1.029, it is necessary, in order to determine differences to the hundredth part, that we should be able to observe accurately the half of a unit in the fourth decimal place. This gives a great extension to the scale, and involves the use of a series of floats if the scale starts from fresh water, or else the instrument assumes dimensions which make it unfit for use on board ship. With a view to the convenient adaptation to practical use this apparatus has been devised for the Coast Survey by Assistant Hilgard.

"The instrument consists of a single float about 9 inches in length. The scale extends from 1.020 to 1.031, in order to give sufficient range for the effect of temperature. Each unit in the third place, or thousandths of the density of fresh water, is represented by a length of 0.3 of an inch, which is subdivided into five parts, admitting of an accurate reading of a unit in the fourth place of decimals by estimation.

"The float is accompanied by a copper case, with a thermometer inserted within the cavity, which is glazed in front. In use the case is nearly filled with water, so as to overflow when the float is inserted, the reading then being taken with ease at the top of the liquid.

"For convenience and security, two such floats and a case are packed together in a suitable case, and a supply of floats and thermometers securely packed in sawdust is kept on hand to replace the broken ones.

"The following table has been derived from the observations of the

expansibility of sea-water made by Prof. J. S. Hubbard, U. S. N. Column II contains a reduction for temperature of salinometer readings to the standard of 60° Fahr. To facilitate the use of this table the following directions are given:

“Record the actual observation of hydrometer and thermometer. From column II (which is applicable to any degree of saltness within the given limits) take the number corresponding to the observed temperature and multiply this number by the number of degrees and fractions of a degree that the observed temperature differs from 60°. Apply this product as a correction, with proper sign, to the reading of the salinometer, and the result will be the reading of the salinometer at the standard temperature of 60° Fahr.

“EXAMPLE.—Actual reading of thermometer=80°.5; actual reading of salinometer=1.02425.

“Opposite 80.°5 in column II is +0.0001585, which, multiplied by 20.5, gives as a product +0.003249. Add this to the observed reading of salinometer, and 1.02750 will result as the reading of the salinometer at the standard temperature.

Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.	Temperature.	Coefficients for reduction to 60°.
°		°		°		°	
50	-0.000108	60	+0.000000	70	+0.000145	80	+0.000158
51	-0.000110	61	+0.000130	71	+0.000146	81	+0.000159
52	-0.000112	62	+0.000135	72	+0.000147	82	+0.000160
53	-0.000113	63	+0.000137	73	+0.000148	83	+0.000162
54	-0.000115	64	+0.000137	74	+0.000149	84	+0.000163
55	-0.000118	65	+0.000138	75	+0.000151	85	+0.000164
56	-0.000120	66	+0.000140	76	+0.000152	86	+0.000166
57	-0.000120	67	+0.000141	77	+0.000154	87	+0.000167
58	-0.000120	68	+0.000142	78	+0.000156	88	+0.000168
59	-0.000120	69	+0.000143	79	+0.000157	89	+0.000170

“A method quite different in practice for determining the density of sea-water has been suggested by Prof. Wolcott Gibbs, of Harvard University. It depends upon the determination of the index of refraction by means of an angular instrument similar to the sextant. As all navigators are familiar with the use of the sextant, and as the observation can be made without hindrance from the motion of the ship, this form of the instrument may be found to possess certain advantages.

“NOTE IN 1876.—When the table of reductions for temperature above given was constructed, the investigations relative to the same subject made by Thorpe and Rücker (Royal Society’s Proceedings, January, 1876) were not known. The following comparison of the results of the experiments on the thermal dilation of sea-water, as taken from Professor Hubbard’s tables, and as derived from the results of Thorpe and Rücker,

shows the differences within the range of temperature covered by our table of corrections:”

Temperature.	Volume.	
	Hubbard.	Thorpe and Rucker.
°		
50	0.99895	0.99902
55	0.99343	0.99946
60	1.00000	1.00000
65	1.00067	1.00059
70	1.00142	1.00127
75	1.00221	1.00205
80	1.00309	1.00280
85	1.00402	1.00364

Plate XLII shows the bow of the Albatross with the sounding machine and dredging boom in position.

The Sigsbee deep-sea sounding machine *a* on the port side of the topgallant forecastle is shown in readiness for taking a sounding.

The working reels containing the sounding-wire are kept in the galvanized-iron tanks *b b* when not in use. Each tank contains sufficient sperm-oil to cover the reel.

The Tanner sounding machine *c* is shown in position on the port rail forward of the fore rigging.

The dredging boom *h* is shown in position for dredging. It is made of spruce, 36 feet in length and 10 inches in diameter, with brass fittings at the ends. The heel pivots in a heavy composition band on the foremast, and the head is held in position by the topping-lift *l* and the guys *m m*.

A beam trawl *d* is shown ready for lowering. The wing nets *e e* are shown in place. The bridle *f f* is seized to the eyebolts on the forward part of the runners, stopped lightly to their after ends, and lashed to the end of the trawl-net. The register *i* is attached to the heel of the boom, and is actuated by a worm wheel on the pulley shaft, thus indicating at all times the number of fathoms of dredge rope out.

The dredging block *g* is seen at the boom end; the accumulator, at *k*; the accumulator block, at *j*; the dredge rope, at *o o*; and the hoisting engine, at *n*.

When the dredging boom is not in use it is lowered, the forward end resting on the topgallant forecastle; the topping-lift is unshackled and secured abreast the foremast, and the guys unhooked and stowed away.

DREDGING BLOCK.

The dredging block used by the Albatross is shown in Plate XLIII, Figs. 1 and 2. The shell *a* is made of two pieces of bar iron $\frac{1}{2}$ -inch thick, $5\frac{1}{2}$ inches in width at one end, $4\frac{1}{2}$ at the other, and $3\frac{1}{2}$ in the center.

They are bolted to a block of wrought iron $5\frac{1}{2}$ inches in length, $2\frac{1}{2}$ inches in width, and $2\frac{1}{2}$ inches in depth, having a hole $1\frac{3}{8}$ inches in diameter through its center in which the shackle bolt *d* is secured. This bolt acts also as a swivel. The sheave *b* is made of composition $21\frac{1}{2}$ inches total diameter, 18 inches at the bottom of the score, and $2\frac{1}{4}$ inches in width. The pin *c* is of cast steel, and is surrounded by six cast-steel friction rollers *i*, $1\frac{1}{4}$ inches in diameter, which work on the inner surface of a wrought-iron bushing in the sheave. The guards *h* are used on the block at the boom end, to prevent the dredge rope from flying out of the score, and the arm *j* is used on the accumulator block for the forward guy which hooks in the eye *k*. The absence of the guards *h* in one block, and the arm *j* in the other, constitute their only points of difference.

THE ACCUMULATOR.

The apparatus shown in Plate XLIV performs the double function of accumulator and dynamometer for the dredge rope.

NOMENCLATURE.

- a.* Buffers.
- b.* Washers.
- c.* Guide rods.
- d.* Tension rod.
- e.* Link.
- f.* Swivel link.
- g. h.* Lock nuts.
- i.* Cross-heads.
- j.* Yoke.
- k.* Tie.

The accumulator is shackled to the topping-lift band 13 inches below the futtock band on the foremast, and is suspended directly forward of the mast. Its total length, including the links *e* and *f*, is 11 feet 1 inch.

The guide rods *c c* are made of one piece of round mild steel, 1 inch in diameter, bent at *e* and *k*, with screw threads and lock nuts at *h h*. The tension rod *d* is also of mild steel, round in section, $1\frac{1}{4}$ inches in diameter, and 9 feet 9 inches net length, that is, measured inside the cross-head *i* and yoke *j*, and it will take thirty-nine buffers without compression. It has a swivel link at the lower end, to which the accumulator block shackles, and a screw thread and lock nuts *g* at the opposite extremity.

The cross-heads *i i i*, the yoke *j*, and the tie *k* are of wrought iron; the former move freely on the guide rods, the upper one receiving the end of the tension rod, and the others support the guide rods. Figs. 3 and 4 show a front and side view of a cross-head.

There is a brass washer *b* between each pair of buffers, separating them from each other, and keeping them from contact with the tension rod, as seen in Fig. 2, where the washer and buffers are shown in section.

The washers are $6\frac{3}{8}$ inches in diameter, three-sixteenths inch thick, and have a hole in the center $1\frac{5}{16}$ inches in diameter. A hub one-half inch in length extends from each side of the washers (Figs. 5 and 6), except those in contact with the yoke and cross-heads, which have no hub on that side. The buffers were purchased of the New York Rubber Belting Company, and are composed of their compound No. 23. They are $5\frac{1}{2}$ inches in diameter, 3 inches thick, have a hole $1\frac{7}{16}$ inches in diameter through their center, weigh 4 pounds 3 ounces, and cost 67 cents per pound, or about \$2.80 each.

A scale not shown in the plate is lashed to one of the guide rods, and marked to indicate the strain on the dredge rope to each 500 pounds by compression of the buffers.

The accumulator is useful, not only to relieve sudden strains brought upon the dredge rope by the vessel's motion in a sea way, but it insures a more uniform action of the hoisting engine, and gives the first indication of increased tension on the rope in case the trawl fouls or buries in the soft bottom when working in deep water.

The hubs on the brass washers, which prevent the buffers from coming in contact with the tension rod, were devised by Lieutenant-Commander Sigsbee, U. S. N., on board of the United States Coast Survey steamer Blake. Previous to their introduction the buffers were liable to grip the tension rod while they were compressed, making the apparatus sluggish in its action, a fault that no longer exists. It is, on the contrary, exceedingly prompt in expansion after being relieved of its load, and retains its elasticity under all conditions of service and temperature.

THE DREDGE ROPE.

Our rope is made of galvanized steel wire, and was manufactured by the Hazard Manufacturing Company, Wilkesbarre, Pa., C. M. Thompson, agent, 87 Liberty street, New York. It is three-eighths inch in diameter and has six strands, laid around a tarred hemp heart. The strands are composed of seven wires, each made according to a special gauge of the manufacturers, approximating to No. 18 American or No. 19 Birmingham gauge. It weighs 1.32 pounds per fathom in air, about 1.2 pounds in water, and its ultimate strength determined by the testing machine at the ordnance department, navy-yard, Washington, D. C., is 12,850 pounds. A kink reduces the strength about 50 per cent.

We first received 4,000 fathoms in one length wound on a heavy wooden reel, from which it was transferred to the working reel. The spare rope was supplied in lengths of 1,000 fathoms, each length wound on a wooden reel. Subsequently the rope was ordered in 500 fathom lengths, the reels being much more convenient for stowage and lighter to handle.

When transferring this rope from one reel to another or when it is in use for trawling or dredging, it is absolutely necessary to keep it under tension, for if slacked from any cause it will kink, continuing to do so

until all the slack is absorbed. This is the one contingency that must be carefully guarded against in the use of this rope.

A "long splice" from 20 to 25 feet in length is used to join two pieces of rope. A man with an assistant will make a splice in about two hours, which, if well made, cannot be detected without close observation, and is as strong as other parts of the rope, at least we have found it to part quite as often away from the splices as at them.

We have used various forms of splice at the end of the rope and have finally settled upon an ordinary eye-splice turned around a large oblong thimble, the ends tucked three times, tapered, and trimmed the same as though it were a hemp or manila rope. We serve the splice occasionally with annealed iron wire when we wish to make a particularly neat job, but it is not at all necessary.

The rope being galvanized requires no preservation while new, but if from long service the zinc should be worn off and the steel wires exposed a coating of raw linseed oil will be of service. We have used no preservative, and have had no trouble from rusting.

SAFETY HOOKS.

The safety hooks (Plate XLV) are designed for the purpose of detaching the trawl or dredge when, from any cause, such as fouling a rock or burying in the soft ooze of the ocean bed, the tension on the dredge rope exceeds the limit of safety.

The rope is spliced into the eye *c*, the spiral spring is adjusted by means of the nut on the end of the tension rod *d*, then placed in the cylinder *a* and the cap *b* screwed on. The shoulders *f f* on the hooks will rest on the inner surface of the lower extremity of the cylinder *a*. The trawl being shackled by passing the pin through the hooks, and the necessary tension being put on it, the spring *e* will be compressed, the shoulders *f f* will extend below the end of the cylinder, and the hooks will open, allowing the shackle pin to slip between them, thus detaching the trawl and relieving the rope from undue strain. The spring can be adjusted to release the trawl at any point between 3,000 and 6,000 pounds.

THE DREDGING AND REELING ENGINES (PLATES XXIII, XXIV, and XXV).

A detailed description of these engines is given in the engineer department and need not be repeated. A brief mention of their design and construction may not, however, be out of place here.

During the summer of 1881, while the plans for the Albatross were being perfected, the writer examined every form of hoisting and reeling engine within reach, as well as models in the Patent Office and plans of engines constructed by various builders, but found nothing fulfilling our requirements. The type adopted on board the Fish Hawk, combining the hoisting and reeling engine, using the same drum for hoist-

ing the trawl and reeling up the rope, was considered; but it was evident that a reel of sufficient capacity for 5,000 fathoms of dredge rope, with strength to withstand the enormous crushing strain it would have to endure, would be too heavy and unwieldy for our purposes, and was consequently discarded.

Having finally recognized the necessity for two separate engines, one for hoisting and another for reeling, we decided to place the former on the spar deck, forward of the foremast, and the latter directly under it on the berth deck, for the double purpose of protecting the machinery and dredge rope from the weather, and placing the weight as low as possible in the vessel. Various plans were considered and rejected for one reason or another, until finally the writer submitted rough pencil sketches of the types considered by him as most nearly answering the requirements, to Mr. Earle C. Bacon, of Messrs. Copeland & Bacon, 85 Liberty street, New York.

He reduced them to proper proportions and perfected such parts as were left to his discretion. They were subsequently ordered from the above-mentioned firm and constructed under the personal supervision of Mr. Bacon. They have performed their work admirably.

THE GOVERNOR.

The hoisting engine being located on the spar deck, and the reeling engine on the deck below, entirely hidden from view, it became necessary to have some automatic device by which the movements of the latter would be governed by those of the former, not only to guard against parting the dredge rope, but to insure a uniform tension on it while being wound on the reel.

With that object in view the writer devised the governor (Plate XXV) described in connection with the reeling engine in the engineer department. The working drawings were made by Passed Asst. Engr. Geo. W. Baird, U. S. N., who superintended its construction. He also suggested attaching the bell crank to a pressure valve instead of the throttle, which is a great improvement, as it leaves the latter under control of the attendant at all times; and the former, once set to the desired tension, requires no further adjustment, and only occasional verification through the medium of a dynamometer.

DEEP-SEA TRAWL.

The deep-sea trawl frame (Plate XLVI) is a slight modification of "the standard trawl for deep-sea work, No. 1," described by Sigbee in *Deep-sea Sounding and Dredging*, p. 151. It is necessary for the successful operation of the beam trawl that it should land on the bottom right side up. The officers of the Blake, having experienced some vexatious delays from capsizing, devised a double trawl which worked equally well either side up, and was subsequently used on board that vessel with excellent results.

The following are the dimensions of the frame and net in use on board of this vessel :

Beams :

Iron pipe, length, 11 feet.

Outside diameter, $2\frac{7}{8}$ inches.

Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 3 inches ; thickness, $\frac{1}{4}$ inch ; length of flange, $9\frac{1}{4}$ inches ; diameter of bolts, $\frac{3}{4}$ inch.

Runners :

Length, 4 feet.

Depth, 3 feet 6 inches.

Width, 3 inches.

Thickness, $\frac{1}{2}$ inch.

Weight of frame, 275 pounds.

Rope for bridle, manila, 3 inches.

Rope for roping, manila, $2\frac{1}{2}$ inches.

Trawl net :

Length, 17 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Pocket :

Length, 6 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 21-thread.

Jacket :

Length, 6 feet.

Size of mesh, square, $\frac{1}{2}$ inch.

Material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for deep-sea work.

The length of the net, including jacket and pocket, is given when it is mounted and on a stretch.

The runners are made of flat bar-iron with a small rod running around their inner surfaces to which netting is laced to fill the spaces and prevent the escape of fish, &c., from the trawl. The runners are tied together rigidly by two beams of wrought-iron piping having a brass collar screwed on each end. These are secured to the runners by screw-bolts.

The netting used for trawl and dredge nets, as well as pockets and jackets, is purchased by the bolt. The net is cut from the bolt, the width of which represents the length of the net ; the edges are then joined by a seam running lengthwise on the upper side of the bag, forming an open-mouthed net which is roped with $2\frac{1}{2}$ -inch manila. That portion forming the loop, intended to drag on the bottom between the runners, is loaded at intervals with lead weights.

The pocket is stitched to the main bag about 3 feet below the lead rope, and the jacket is laced its width above the lower end of the net, so that the edges of both come together. The bag is attached to the rear ends of the runners by strong seizings at the four corners, leaving the lead ropes sufficiently slack for the upper one to touch the beam. A netting is usually stretched between the beams.

Floats are attached to the net a few feet from the lead rope by means

of a slack line, to prevent the upper part of the bag from falling and obstructing the mouth while dragging.

The bridle is practically the same as suggested by Sigsbee. Large eyes are spliced in the ends of a 3-inch rope, a thimble turned in the middle, and an overhand knot taken in each leg at the point of contact with the eyebolts on the front of the runners. Seizings are passed through the eyebolts and around the bridle legs forward of the knots, and the ends of the legs are securely lashed to the tail of the trawl net. Should the trawl foul on the bottom or take in a dangerously heavy load it is intended that the seizings shall part, and the trawl be drawn up tail foremost. The strength of seizings required for this purpose at the forward end of the runners is determined by experiment.

We have used the trawl described above with good results in deep water. It is not, however, adapted for use on the hard sandy bottom usually encountered in shoal water, for the reason that sufficient sweep cannot be given the lead rope. It has another fault which has practically driven it out of use on board of this vessel. It will be seen by reference to the plate that the mouth of the trawl will be extended equal to the depth of the runners while being hove up; consequently the wash of water through the meshes of the net must be very great; so great, in fact, that in a sea-way it often seriously injured the specimens.

BEAM TRAWL.

The beam-trawl frame, Plate XLVII, shows the form in use on board of this vessel, both for shoal and deep-water work.

The following are the dimensions of the frame and net:

Beam:

Iron pipe, length, 11 feet.

Outside diameter, $2\frac{7}{8}$ inches.

Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 4 inches; thickness, $\frac{1}{4}$ inch; length of flange, $9\frac{1}{2}$ inches; diameter of bolts, $\frac{3}{4}$ inch.

Runners:

Length, 5 feet.

Height, 2 feet 5 inches + 4 inches; total, 2 feet 9 inches.

Width, 4 inches.

Thickness of metal, $\frac{3}{4}$ inch.

Weight of trawl frame, 365 pounds.

Rope for bridle, 3 inches.

Rope for lead rope, 2 inches.

Rope for head rope, $1\frac{1}{2}$ inches.

Trawl net:

Length, 17 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Pocket, length, 6 feet.

Pocket, size of mesh, square, 1 inch.

Pocket, material, cotton, barked, 21-thread.

Jacket, length, 6 feet.

Jacket, size of mesh, square, $\frac{1}{2}$ inch.

Jacket material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for deep-water work.

WING NETS.

Various forms of nets have been used to collect minute specimens at intermediate depths, but Capt. H. C. Chester was the first, I believe, to attach the net to the trawl frame. This he did by hanging a small cheese-cloth net to a piece of iron pipe, one end of which was inserted in

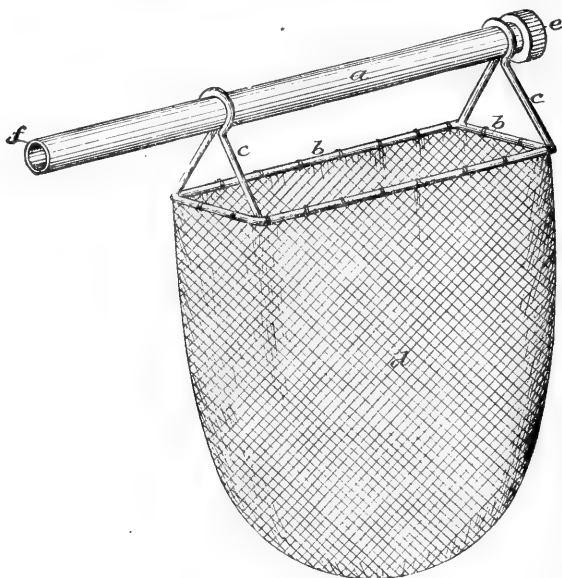


FIG. 19.—Chester's wing net.

the trawl beam, and held in place by a set screw. The iron pipe *a* has a ring *e* at its outer end to prevent the arms *c c* from slipping off. The arms, the frame *b*, and the net *d* are suspended from the pipe which is inserted into the end of the trawl beam at *f*. The arms swing freely on the pipe.

DIMENSIONS.

- Iron pipe, *a*, length, 3 feet.
- Iron pipe, *a*, diameter, 2 inches.
- Iron cap, *e*, length, 1 inch.
- Iron cap, *e*, diameter, $2\frac{7}{8}$ inches.
- Frame, length, 2 feet.
- Frame, width, 8 inches.
- Frame, diameter, round iron, $\frac{1}{2}$ inch.
- Arms, length, 6 inches.
- Arms, diameter, round iron, $\frac{1}{2}$ inch.
- Bag, length, 2 feet.
- Bag, size of mesh, square, $\frac{3}{16}$ inch.
- Bag, material, cotton, 3-thread.
- Bag, bottom-lining, cheese-cloth.

Subsequently the bottom lining was discarded and an ordinary surface towing net inserted, the ring seized to the sides of the net *d*. This net has proved a valuable adjunct to the trawl.

MUD BAG.

The mud bag used by us with the trawl is simply a boat dredge with the net removed and the rear end of the canvas shield closed, making a water-tight bag. We lash this to the tail of the trawl net and usually find it filled with a compact mass of mud or ooze when it comes up. This affords many interesting specimens besides enabling us to determine the character of the bottom more accurately than we could by examining the small amount brought up in the specimen cup.

IMPROVED BEAM TRAWL.

This trawl, Plate XLVIII, was introduced by the writer in 1884* and is the latest form used on board the Albatross. It is a modification of the one shown in Plate XLVII.

NOMENCLATURE.

- a. Beam, iron pipe.
- b. Runners.
- c. Trawl net.
- d. Pocket.
- e. Jacket.
- f. Bridle.
- g. Shackle.
- h. Lashings.
- i. Mud bag.
- j. Lead rope.
- k. Arms, wood.
- l. Wing nets.
- m. Guard nets.
- n. Dredge rope.
- o. Dredging block.
- p. Dredging boom.
- q. Bridle stops.
- r. Collars, brass.

DIMENSIONS.

Beam :

- Iron pipe, length, 11 feet.
- Outside diameter, $2\frac{7}{8}$ inches.
- Thickness of metal, $\frac{3}{16}$ inch.

Collars :

- Brass, width, $3\frac{1}{2}$ inches.
- Thickness, $\frac{3}{4}$ inch.
- Length, $9\frac{1}{2}$ inches.

Bolts :

- Iron, round, diameter, $\frac{3}{4}$ inch.
- Set screws, in collars, iron, square heads, diameter, $\frac{3}{4}$ inch.

Runners :

- Iron, flat-bar, length, 5 feet.
- Height, 2 feet 5 inches.
- Height, including collars, 2 feet 9 inches.
- Width, $3\frac{1}{2}$ inches.
- Thickness of metal, $\frac{1}{2}$ inch.

* Owing to delay in printing we are able to introduce this and other late improvements into this report.

Jackstays:

Iron, round, diameter, $\frac{1}{4}$ inch.

Eyebolts, brass; diameter of metal, $\frac{3}{8}$ inch.

Arms:

Wood, for wing nets, length, 2 feet 6 inches.

Wood, for wing nets, diameter, $2\frac{1}{2}$ inches.

Weight:

Frame, 275 pounds.

Bridle:

Rope, circumference, 3 inches.

Net:

Lead rope, circumference, 2 inches.

Head rope, circumference, $1\frac{1}{2}$ inches.

Length, 17 feet.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Pocket, length, 6 feet.

Pocket, size of mesh, square, 1 inch.

Pocket material, cotton, barked, 21-thread.

Jacket, length, 6 feet.

Jacket, size of mesh, square, $\frac{1}{2}$ inch.

Jacket material, cotton, barked, 16-thread.

Bottom lining of cheese-cloth for very deep water work.

It will be observed that there is no change in the beam, and the runners remain the same in height and length, but they are much reduced in weight and so modified in form as to avoid sharp angles in the net, thus equalizing the strain over its various parts and largely increasing its limit of safety.

The jackstays on the inner surfaces of the runners and the guard nets which are laced to them are not new, but we have confined their use heretofore to the small beam trawls and deep-sea trawls. There is no doubt that they prevent the escape of many fish and other quick moving objects.

The trawl-net is the same in every particular as that already described for the beam trawl, and the bridle is fitted and secured precisely in the same manner. The mud bag is also the same.

WING NETS.

The wing nets shown in Plate XLVIII were devised by the writer in 1884, and the pocket introduced to prevent the escape of specimens after having entered the nets. They are made of cheese-cloth in the following manner:

The material is laid on deck and folded once lengthwise, a pattern is then placed over it and the two halves cut from the piece at the same time; the side seams are sewed up, the ends hemmed, and one end turned in over a galvanized-iron ring, thus forming the pocket. The double bridle is seized to the ring through the net and serves to hold it in place. The lashing is stopped to the lower end of the net to prevent its loss when cast adrift. And to prevent the pocket from turning

wrong side out a small piece of twine, with a knot on its lower end, is allowed to hang down from it far enough to be gathered in with the end of the net and secured with the lashing.

The bridles are seized in scores cut in the arms for the purpose. When required for use the arms are inserted in the ends of the beam and held in place by the set screws in the collars.

DIMENSIONS OF WING NETS.

- Galvanized-iron ring, diameter, 1 foot.
- Galvanized-iron ring, diameter of iron, $\frac{5}{8}$ inch.
- Net, length, 3 feet.
- Pocket, length, 2 feet.

SMALL BEAM TRAWL.

The small beam trawl is used during bad weather, being easier to handle and bringing less strain on the dredge rope. The dimensions of the frame and net are as follows :

Beam:

- Iron pipe, length, 7 feet 6 inches.
- Outside diameter, $2\frac{1}{2}$ inches.
- Thickness of metal, $\frac{3}{16}$ inch.

Collars, brass, width, 2 inches; thickness, $\frac{1}{2}$ inch; length of flanges, 7 inches; diameter of bolts, $\frac{5}{8}$ inch.

Runners:

- Length, 4 feet.
- Height, 2 feet 3 inches + 3 inches; total, 2 feet 6 inches.
- Width, 2 inches.
- Thickness of metal, $\frac{5}{8}$ inch.

Weight of trawl frame, 140 pounds.

Rope for bridle, $2\frac{1}{2}$ inches.

Rope for lead rope, 2 inches.

Rope for head rope, $1\frac{1}{2}$ inches.

Trawl net:

- Length, 17 feet.
- Size of mesh, square, 1 inch.
- Material, cotton, barked, 21-thread.
- Pocket, length, 6 feet.
- Pocket, size of mesh, square, 1 inch.
- Pocket material, cotton, barked, 21-thread.
- Jacket, length, 6 feet.
- Jacket, size of mesh, square, $\frac{1}{2}$ inch.
- Jacket material, cotton, barked, 16-thread.

The method of attaching the beams to the runners is the same with both the deep-sea and beam trawl frames. Heavy brass collars are secured to the ends of the beams by screw threads, and to the runners by two bolts and nuts through each collar and runner, thus giving the frames the required rigidity. The parts can be assembled and dismounted in a few minutes; in fact, so readily that it has become a custom with us to dismount and stow the frames away whenever they are not required for immediate use,

• THE DREDGE.

The dredge in ordinary use on shipboard, Plate XLIX, Fig. 1, is composed of two jaws or mouth pieces, flaring about 12 degrees, and joined together by an iron stud at each end, which is welded to the jaws. The net is laced through holes along the back of the mouth-pieces, and is protected from chafing on the bottom by a canvas shield drawn over it and laced through the same holes.

Short iron arms serve as a bridle, one being a few inches longer than the other and secured to it by a seizing, which is intended to part whenever undue strain is brought upon it and allow the dredge to be drawn up end on, in which position it would be most likely to free itself from an obstruction. The dredge used on board the Albatross is of the following dimensions:

Jaws:

Length, 2 feet.

Width, $2\frac{1}{4}$ inches.

Opening between, 8 inches.

Angle of, 12 degrees.

Stud:

Length, 6 inches.

Diameter, round iron, $\frac{3}{4}$ inch.

Bridle:

Diameter, round iron, $\frac{3}{4}$ inch.

Weight of metal part, 26 pounds.

Net:

Length, 3 feet 6 inches.

Size of mesh, square, 1 inch.

Material, cotton, barked, 30-thread.

Jacket, length, 2 feet 6 inches.

Jacket, size of mesh, $\frac{1}{2}$ inch.

Jacket material, cotton, barked, 16-thread.

Bottom lining, cheese-cloth.

Shield, length, 3 feet 8 inches.

Shield, material, No. 2 cotton canvas.

The dredge described above, having its jaws set at an angle, is inclined to plow the bottom, and, where the latter is soft, bury itself beneath the surface. This is a necessary feature on a hard sandy bottom, but in the soft ooze of the deep sea it is a serious detriment. Various devises were resorted to by Lieutenant-Commander Sigsbee on board the Blake, and finally the following form was adopted and called the "Improved dredge." It is known here as the "Blake dredge," and will be referred to under that name, Plate XLIX, Figs. 3 and 4.

The following description is from Sigsbee's Deep-sea Sounding and Dredging:

"By reason of having flaring mouth pieces and a flexible body composed of the bag and shield, the old pattern dredge is almost sure to

plow deeply into yielding bottoms. Since the object sought in the fashioning of the new dredge was to effect a skimming of the bottom rather than a deep penetration therein, a very decided departure from the form of the old dredge was necessary. The frame of the new is a rectangular skeleton box made of wrought iron. The mouth pieces are flat, beveled on the forward inner edges, perforated along the rear edges, as on the old dredge, and riveted to the skeleton or bar-iron portions of the frame-work, in which position they are held parallel.

"The rear of the upper and lower sides of the skeleton are connected by three riveted braces, the whole frame-work being rigid. A tangle bar of heavy wood, bar-iron, or iron pipe, to carry the weights and tangles, has seized to it three sister hooks, which are hooked severally around the braces and moused. The arms are like those of the old dredge, one arm being longer than the other. A netting bag and canvas shield, as in the case of the old dredge, are stitched with pliable wire to the dredge frame. A trap like that of the trawl is fitted inside the main bag. The bottom of the main bag is stopped to the middle brace at the rear of the frame. Each flap of the canvas shield is turned over and around its own side and end of the skeleton frame, and stitched to its own part with stout twine, presenting a tolerably smooth sliding surface."

DIMENSIONS OF THE BLAKE DREDGE AS USED ON BOARD OF THIS VESSEL.

Jaws:

Length, 4 feet.

Width, 6 inches.

Thickness of metal, $\frac{3}{8}$ inch.

Distance of holes from edge, three-eighths of an inch.

Distance between holes, 2 inches.

Depth or opening between jaws, 9 inches.

Skeleton frame:

Length, including width of jaws, 4 feet.

Diameter of round iron, one-half inch.

Diameter of braces, three-fourths of an inch.

Long arm, length 4 feet.

Short arm, length 3 feet 9 inches.

Diameter of round iron, both arms, three-fourths of an inch.

Weight of dredge and frame, 81 pounds.

Shield, cotton canvas, No. 2.

Net:

Length, 5 feet.

Size of mesh, square, 1 inch.

Net material, cotton, barked, 30-thread.

Jacket:

Length, 3 feet.

Size of mesh, square, one-half inch.

Jacket material, cotton, barked, 16-thread.

Bottom lining, cheese-cloth.

THE CHESTER RAKE DREDGE.

Plate XLIX, Fig. 2, shows the Chester rake dredge designed for the purpose of obtaining mollusca, annelids, crustacea, &c., which burrow beneath the surface out of reach of any other apparatus in use by the United States Fish Commission.

The rake is shackled to the dredge rope, and a Blake dredge, secured to eyebolts on the rear of each end of the frame, following it as it is dragged over the bottom, picking up whatever is turned over by its strong harrow-like teeth.

DIMENSIONS OF THE CHESTER RAKE.

Frame :

- Length, 3 feet.
- Depth of opening, 10 inches.
- Width of metal, $2\frac{1}{2}$ inches.
- Thickness of metal, one-half inch.

Teeth :

- Length, 7 inches.
- Width of base, pointed, $2\frac{1}{2}$ inches.
- Thickness of metal, base, one-half inch.

Arms :

- Length of long arm, 3 feet 5 inches.
- Length of short arm, 3 feet 3 inches.
- Diameter, round iron, three-fourths of an inch.

Weight, 79 pounds.

This admirable instrument was devised by Capt. H. C. Chester, to whom the Commission is indebted for many practical suggestions as well as for some of its most valuable apparatus.

BOAT DREDGE.

The boat dredge is essentially a miniature form of the ordinary ship's dredge already described, and is designed for use from boats where it must be worked by hand.

DIMENSIONS OF THE BOAT DREDGE.

Jaws :

- Length, 1 foot 7 inches.
- Width, $2\frac{1}{2}$ inches.
- Opening, $7\frac{1}{2}$ inches.
- Angle, 12 degrees.

Stud :

- Length, $6\frac{1}{2}$ inches.
- Diameter, round iron, five eighths of an inch.

Bridle :

- Diameter, round iron, one-half inch.
- Length, 1 foot 5 inches.

Weight, 15 pounds.

Net :

- Length, 1 foot 8 inches.
- Size of mesh, square, three-sixteenths of an inch.
- Material, cotton, 3-thread, bottom double.

Shield :

- Length, 2 feet 8 inches,
- Material, No. 3 cotton canvas.

TRAWL WEIGHTS.

It is customary with us to attach one or more trawl weights to the tail of the trawl net, and, in shoal water, one to each runner. Two or three are also used with the dredge and tangles.

DIMENSIONS.

Length, 11 inches.

Diameter of base, square, 4 inches.

Diameter $8\frac{1}{4}$ inches above base, 3 inches.

Size of hole, 1 inch by $1\frac{1}{4}$ inches.

Thickness of metal around hole, three-fourths of an inch.

Material, cast iron.

Weight, 27 pounds.

THE TANGLE BAR (PLATE L).

The form of tangle bar used was devised by Prof. A. E. Verrill in 1873, and consists of an iron bar supported at each end by a fixed wheel, or iron hoop. Six chains about 12 feet in length are attached to the bar at intervals of 1 foot. To these chains are secured deck swabs, or bundles of rope yarns, at intervals of about 18 inches.

It is very useful on rocky bottoms where it will capture specimens when no other device could be made available.

DIMENSIONS.

Wheels :

Diameter, 1 foot 2 inches.

Width, $2\frac{1}{2}$ inches.

Thickness of iron, one-half inch.

Width of cross-bars, $2\frac{1}{2}$ inches.

Thickness of cross-bars, three-fourths of an inch.

Chain bar :

Length, 6 feet.

Width, $2\frac{1}{2}$ inches.

Thickness, 1 inch.

Rings for drag rope, diameter, 4 inches.

Rings for drag rope, diameter of iron, five-eighths of an inch.

Tangle chains :

Diameter of iron, three-eighths of an inch.

Length, 12 feet.

Tangles, hemp, length, 3 feet.

THE TANGLES.

The tangles, Plate LI, were devised by the writer in 1884 as an improvement on the tangle bar, being less liable to foul on the rough rocky bottoms where it is generally used.

NOMENCLATURE.

a. Bow.

b. Tangle bars.

c. Tangles.

d. Eyebolts.

e. Bolts and nuts.

- f.* Arm.
- g.* Eyebolt.
- h.* Sinker.
- i.* Dredge rope.
- j.* Dredging block.
- k.* Dredging boom.

DIMENSIONS.

Bow (steel):

- Diameter, 11 inches.
- Width at center, 3 inches.
- Width at ends, $2\frac{1}{2}$ inches.
- Thickness at ends, one-half inch.
- Thickness at center, one-fourth of an inch.

Tangle bars (iron):

- Length, 5 feet.
- Width, $2\frac{1}{2}$ inches.
- Thickness, one-half inch.
- Number of holes for tangles, 5.
- Diameter of holes, five-eighths of an inch.

Eyebolts for tangles (iron), diameter, one-fourth of an inch.

Tangles (hemp), length, 4 feet.

Tangles (beckets), 21-thread ratlin stuff.

Arm (mild steel):

- Semi-circular, diameter, 1 foot 6 inches.
- Width of metal, $2\frac{1}{2}$ inches.
- Thickness of metal, one-half inch.

Eyebolt (iron), diameter of metal (square), five-eighths of an inch.

Sinker (cast-iron):

- Diameter, 9 inches.
- Weight, 150 pounds.

The first tangle of this form was improvised at sea, after expending the last tangle bar, by bending a bar of iron in the form of a **V**, the tangles being seized to a 3-inch rope, which was drawn around the frame and secured to it by lashings. It worked so well that we used it the remainder of the cruise and finally adopted the present form.

The bow *a* is made of spring-tempered steel and permits the bars to close with a pressure of between 300 and 400 pounds applied to their extremities, so that the apparatus will pass between rocks or other obstructions which permit the passage of the bow and sinker.

Each tangle is secured to its bar by a one-fourth inch eyebolt, which draws at a tension of about 1,000 pounds, releasing its tangle when irretrievably fouled on the bottom without endangering the loss of the whole apparatus. The tangle bars were made separately from the bow and attached by bolts and nuts at *e* to secure better stowage and make the parts lighter to handle. The semicircular arm *f* is intended to raise the forward end of the tangle frame a few inches off the bottom; also to act as a shoe in dragging over rocks or other uneven surfaces. It is held in position by the eyebolt *g*, which is square and fits snugly in square holes in the arm and bow.

The tangles are, in material, size, and structure, practically the same as the deck swabs in general use on board ship.

THE TABLE SIEVE.

The table sieve in its present form, Plate LII, Fig. 2, is an outgrowth of the cradle sieve, Plate LII, Fig. 1, which was formerly used in washing the contents of the dredge, the more bulky loads of the trawl having been emptied on deck.

The first table sieve was devised by Capt. H. C. Chester and Prof. A. E. Verrill, and consisted of a rectangular table supporting a fine sieve, and over it the hopper with its coarse wire netting.

The canvas bottom and chute were added by Mate James A. Smith, U. S. N., executive officer of the U. S. S. Speedwell, while in the employ of the United States Fish Commission, about 1877.

To prepare the table sieve for use, place the sieve *c* in the frame *a* on cleats provided for it a few inches above the canvas bottom *d*; then place the hopper in the frame over the sieve and carry the chute *e* to a scupper.

DIMENSIONS.

Table frame:

Length, 5 feet 6 inches.

Breadth, 3 feet 2 inches.

Depth, 1 foot.

Height from deck to top of frame, 3 feet 2 inches.

Thickness of planks, 1 inch.

Hopper:

Length, top, 5 feet 9 inches.

Length, bottom, 4 feet.

Width, top, 3 feet 5 inches.

Width, bottom, 2 feet 6 inches.

Depth, 1 foot 1 inch.

Thickness of planks, 1 inch.

Size of mesh, galvanized-iron wire netting, five-eighths of an inch.

Sieve:

Length of frame, 5 feet 3 inches.

Breadth, 2 feet 11½ inches.

Depth, 2½ inches.

Thickness of planks, 1½ inches.

Size of mesh, galvanized-iron wire netting, one-twelfth of an inch.

Bottom, No. 4 cotton canvas.

The table legs are now made detachable, which materially reduces the space required for stowage.

THE CRADLE SIEVE.

This sieve was devised by Prof. A. E. Verrill in the early days of the United States Fish Commission, for the purpose of rapidly washing out the mud brought up by the dredge. It has wooden ends nearly semi-circular in form, joined by narrow strips which are let into the end pieces so as to present a smooth surface. A fine netting is drawn over the surface, and supported by an outer netting of coarse mesh secured firmly to the ends and side pieces. An inner sieve with coarse mesh

rests on and partially inside of the main sieve. It is intended to be hung over the vessel's side by means of a rope bridle attached to iron straps on the end pieces.

In use it has been superseded by the table sieve.

DIMENSIONS OF CRADLE SIEVE.

Length, 3 feet.

Breadth, 1 foot 6 inches.

Depth, 1 foot.

Width of side pieces, $3\frac{1}{2}$ inches.

Thickness of side pieces and ends, 1 inch.

Depth of inner sieve, 8 inches.

THE STRAINER.

The strainer, Plate LII, Fig. 3, was introduced by Mr. James E. Benedict, resident naturalist of the Albatross, for the purpose of passing all water used for washing the mud out of the table sieve through strainers fine enough to retain minute annelids, foraminifera, &c., which would otherwise be lost.

Its construction is very simple. An oil barrel was cut down until it would slide under the table sieve. Three iron drain-pipes are inserted in the side, one diagonally over the other, and attached to them are three strainers, *a*, *b*, and *c*, Fig. 3, made of linen scrim, through which the water is drained as it rises successively to the level of each. The combined areas of the three are sufficient to carry off the water supplied by the steam hose under ordinary circumstances. When it is to be used in connection with the table sieve the long chute *e* is removed, and a short one about a foot in length substituted, the water being discharged directly into the strainer.

DREDGING QUADRANT.

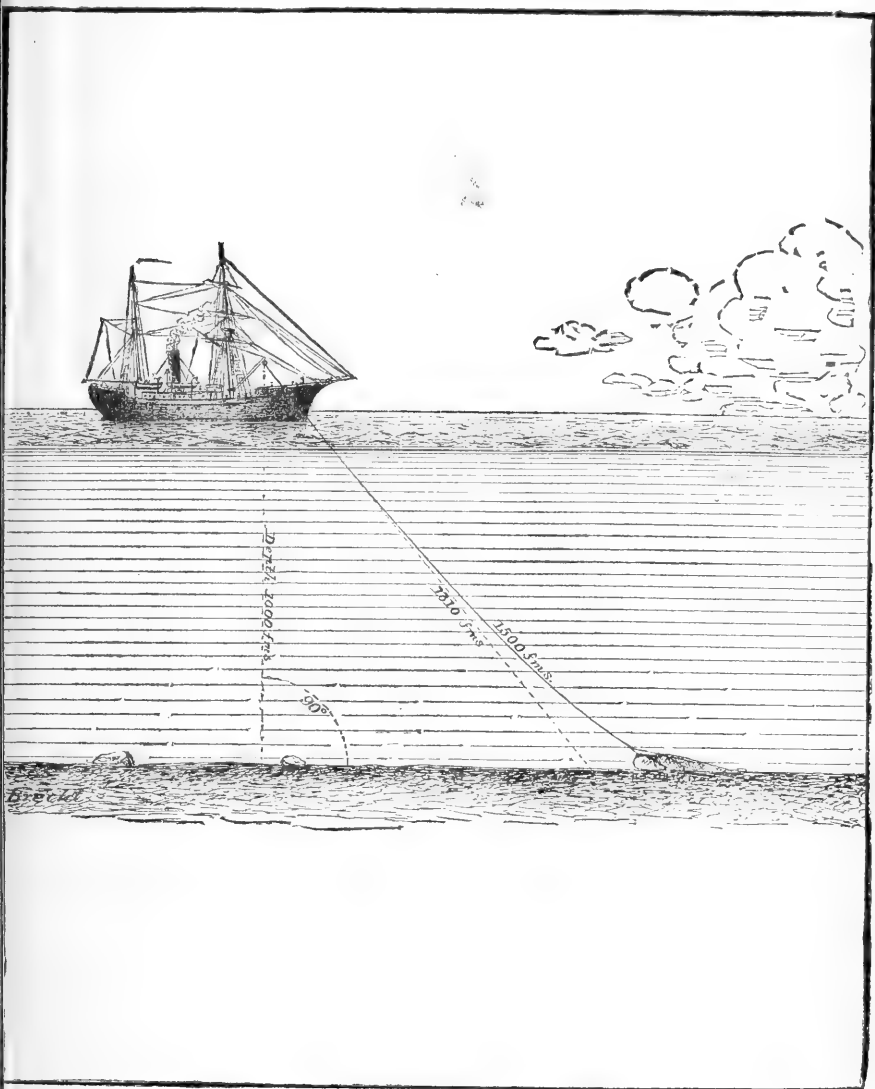
The dredging quadrant, Plate XXVIII, was devised by the writer for the purpose of ascertaining approximately the position of the trawl when working in deep water by observing the angle of the dredge rope. The instrument was improvised while working in over 2,500 fathoms in the Gulf Stream, where the necessity for a guide of some sort was seriously felt.

It is made of black walnut, 2 feet in length and three-quarters of an inch in thickness; the arms are 2 inches in width and the graduated semicircle or double quadrant is 8 inches in diameter. The graduation is on the periphery from 0, when the instrument is held vertically, to 90 degrees to the right and left. The pointer is made of lead one-sixteenth inch in thickness, and swings freely on its pivot.

The figures were stamped with ordinary dies and the depressions filled with white lead. The original instrument is still in use, it having answered the purpose so well that we have had no disposition to replace it.

THE ANGLE AND SCOPE OF DREDGE ROPE.

Its use will be readily understood by reference to the above cut where the vessel is backing and the rope trending ahead. The officer in charge, taking the quadrant in both hands and placing himself in proper position, glances along its straight-edge, inclining it until it is parallel with



the dredge rope. The pointer retains its vertical position by gravity, and consequently indicates the angle from the perpendicular at which the instrument is held or the angle of the dredge rope, which, in this case, is 40 degrees. Enter Table II, Bowditch, with this angle as a

course, and find the depth, 1,000 fathoms, in the difference of latitude column (taking one-tenth of the amount), 100.4 being the nearest number. Opposite to this, in the distance column, is 131, which being multiplied by 10 gives 1,310 fathoms, the hypotenuse of the right triangle we have constructed. As the rope has a catenary curve it is necessary to make an allowance in order to insure the trawl reaching and remaining on the bottom. Experience has taught us that about 200 fathoms is sufficient with the above depth and angle; therefore, with a scope of 1,500 fathoms, and the angle of the rope maintained between the limits of 35 degrees and 40 degrees, a successful haul may be anticipated as far as the landing and dragging of the trawl on the bottom is concerned. The speed can be easily regulated, after a little practice, so as to confine the rope between the above limits.

The quadrant is made double in order that it may be used on either side of the vessel, whether steaming ahead or backing.

SIGSBEE'S GRAVITATING TRAP (PLATES LIII, LIV, AND LV).

The tow net was among the first apparatus used by naturalists to obtain minute animal forms from the surface of the sea, and the same apparatus has been used for collecting at intermediate depths, various methods being employed for sinking it. The range was confined within narrow limits, generally not exceeding a few fathoms below the surface, and even then it was not altogether satisfactory, as specimens might be taken while sinking the net, or hauling it up, their habitat still remaining a mystery.

The dredge rope was brought into requisition on the *Challenger*, the tow net being secured at the point required to sink it to the desired depth, but the same cause for doubt still existed as to the locality in which specimens were caught in the open-mouthed net, which was twice dragged through the intervening space between the surface and the working depth. The same practice was followed on board of the *Fish Hawk* until we improved upon it by adopting the wing nets, which were secured to the ends of the trawl beam and acted as collectors from the surface to the bottom, along the bottom as far as the trawl was dragged, and again from the bottom to the surface. There was no pretense of locating the habitat of the myriads of specimens taken in this manner, the nets being used for the simple purpose of making the capture.

The specimens procured by any of the methods above mentioned cannot be assigned to determinate depths. Feeling the need of some device by which this desirable end could be obtained, Prof. Alexander Agassiz, in 1880, requested Lieut.-Commander C. D. Sigsbee, U. S. N., to co-operate with him in devising the necessary apparatus.

Sigsbee says, with reference to the matter (*Bulletin of the Museum of Comparative Zoology, Cambridge*, vol. vi, pp. 155-6):

"It occurred to me that by using an apparatus in connection with a line and lead, paid out vertically as in sounding, and by dragging ver-

tically instead of horizontally, as formerly, there would be as much certainty with regard to depths as in the old method, and that simple mechanical devices could be invented to satisfy the conditions of the work. The scheme has been stated in my volume on Deep sea Sounding and Dredging (p. 145, foot-note) as follows:

“Our plan is to trap the specimens by giving to a cylinder, covered with gauze at the upper end and having a flat valve at the lower end, a rapid vertical descent between any two depths as may be desired, the valve during such descent to keep open, but to remain closed during the process of lowering and hauling back with the rope. An idea of what it is intended to effect may be stated briefly thus: Specimens are to be obtained between the intermediate depths *a* and *b*, the former being the uppermost. With the apparatus in position, there is at *a* the cylinder suspended from a friction clamp in such a way that the weight of the cylinder and its frame keeps the valve closed; at *b*, there is a friction buffer.

“Everything being ready, a small weight or messenger is sent down, which on striking the clamp disengages the latter and also the cylinder, when messenger, clamp, and cylinder descend by their own weight to *b*, with the valve open during the passage. When the cylinder frame strikes the buffer at *b*, the valve is therefore closed, and it is kept closed thereafter by the weight of the messenger, clamp, and cylinder. The friction buffer, which is 4 inches long, may be regulated on board to give as many feet of cushioning as desired.”

The following is a detailed description of the apparatus:

NOMENCLATURE.

- A. Cylinder, copper.
- B. Frame, wrought iron.
- C. Flap or clapper valve.
- D D. Levers.
- E. Pivot.
- F. Wire sieve (60 wires to the inch).
- G. Wire sieve (27 wires to the inch).
- H. Wire funnel or trap (27 wires to the inch).
- I I. Loops on fairleaders.
- J J. Rollers.
- K. Frame of friction clamp.
- L. Sliding chock.
- M. Sliding chock.
- N. Adjusting screw.
- O. Sling.
- P. Eccentric tumbler.
- Q. Frame of friction buffer.
- R. Sliding chock.
- S. Sliding chock.
- T. Adjusting screw.
- U. Compression spring.
- V. Regulating screw.
- W. Key.
- X. Messenger, cast-iron.

Plate LIII shows the apparatus properly adjusted on the steel-wire dredge rope ready for use. The cylinder A is suspended to the friction clamp by the tumbler P, and confined to the dredge rope by means of the fairleaders I I. The friction buffer is clamped to the rope beneath the cylinder, and the messenger is shown above the apparatus in the act of descending.

Plate LIV shows a detailed plan of the cylinder as follows: Fig. 1, a vertical sectional elevation; Fig. 2, a side view; Fig. 3, a top view; and Fig. 4, a bottom view. The copper cylinder A is secured to the wrought-iron frame B by brass screws, and at the bottom of the frame there is a flap or clapper valve C, which is pivoted at E and opened inwards. It is actuated by the levers D D. The wire sieve F is clamped to the top of the cylinder A; the sieve G is inside of the cylinder A, and is supported on the top of the frame or trap H; the latter being supported on a brass ring secured to the inner surface of the cylinder A, and is held in place by brass clamps. Both the sieve G and the trap H are readily removed.

The steel-wire dredge rope on which the cylinder travels is seen in the fairleaders I I, where it is held in place by the rollers J J.

Fig. 1 of Plate LV is a side view of the friction buffer; Fig. 2 is a sectional elevation; Fig. 3 is a top view; and Fig. 4 is also a top view with the steel face-plate removed.

The frame A of the buffer is made of brass; the sliding chocks R and S, adjusting screw T, compression spring U, and regulating screw V are of steel. The sliding chocks work in the apertures in the frame as shown in Figs. 2, 3, and 4. Their bearing surfaces are corrugated and their inward movement is limited by studs which are part of the frame and fit loosely within a slot in the chocks.

* "In clamping the buffer to the rope the chock R is always screwed in until stopped by its stud; the steel rope is therefore always pressed between the two chocks by the elastic force of the spring, which may be regulated as desired. To regulate the buffer for any definite frictional resistance, clamp it to the rope, and move the regulating screw V well inward; then suspend from the buffer a weight equal to the resistance decided upon. Move the regulating screw outwards until the buffer slides down the rope under the influence of the suspended weight.

"Since the chock R is always screwed down in clamping the rope, the buffer remains regulated for prolonged use with the same resistance; and if the latter proves satisfactory it is probable that the regulating screw need not be touched again for a whole cruise, if the buffer is rinsed in lye-water each time after use."

Fig. 5 is a top view of the friction clamp, and Fig. 6 a side view. The frame K is of brass; the sliding chocks L and M, adjusting screw N, and eccentric tumbler P are made of steel.

Fig. 7 is a side view of the messenger X, Fig. 8 a sectional elevation,

and Fig. 9 a cross-section. The messenger is made of cast iron in two parts, which are held in position on the rope by lashings passed in the scores prepared for the purpose. The key is shown in Fig. 10.

WORKING THE APPARATUS.

* "It is necessary first to regulate the buffer to cushion the stoppage of the falling weights, which are, cylinder and frame, 38 pounds, clamp 4 pounds, messenger 8 pounds, total 50 pounds. The Blake adopted a resistance of about 80 pounds (this resistance being of course constant during the whole movement of the buffer), it having been found that a blow of that force resulted in no injury to the apparatus.

"On the ascent the buffer must withstand not only the weight of the 50 pounds of metal, but also the resistance which the water offers to the passage through it of the several parts of the apparatus. Moreover, when the cylinder emerges from the water it is full of that liquid and with this increased weight would overcome the stated resistance of the buffer and force the latter downwards until the lead was reached. To meet these conditions it was not thought advisable to increase the resistance of the buffer, which would involve a heavier blow against the apparatus, but a rope-yarn seizing or stop was placed on the rope about 15 or 20 feet below the buffer, beyond which the latter could not pass.

"Having secured the buffer to the rope about 5 or 6 fathoms above the lead (a very heavy lead to keep the rope straight) and paid out the length of rope required to span the stratum to be explored by the cylinder, the clamp and cylinder are attached, the latter being suspended from the former as follows:

"The rope having been placed between the two sliding chocks of the clamp, the arm of the eccentric tumbler is thrown up, which moves the chock M inwards; then, by means of the adjusting screw, the chock L is pressed against the rope, securing the clamp in position. The cylinder hangs 4 or 5 inches below the clamp and is supported by a loop of soft wire which rests on the lip of the tumbler; the ends of the wire, being run through holes in the upper part of the frame of the cylinder, are fastened permanently to the outer arms of the lever D, to which the valve is screwed. It is seen that by this method of suspension the weight of the cylinder and its frame is used to keep the valve closed while paying out. The cylinder should be filled with water, poured down through the upper sieve, to maintain the valve on its seat while the cylinder is being immersed. Rope is then paid out slowly until the cylinder is at the desired depth, when the rope is stoppered and the messenger sent down. The messenger strikes the arm of the eccentric tumbler, throwing it down and tripping the cylinder. The tumbler in falling relieves the pressure on the sliding chock M, which is then free to recede from the rope.

"Messenger, clamp, and cylinder fall together, the valve being held

* Sigsbee.

open by the resistance of the water. A current is established through the cylinder, and specimens which enter are retained by the upper sieve. When the buffer is reached, the valve is closed by the pressure against the outer arms of the lever.

"A very slight pressure on the adjusting screw of the clamp, after the chocks are bearing against the rope, is enough to prevent the clamp from slipping, but by an increased pressure on the screw a greater force is required to trip the tumbler, and by this feature the arm of the tumbler is utilized to break the force of the blow which the body of the clamp receives from the falling messenger.

"A few rings of sheet-lead may be laid on the top of the clamp and buffer respectively."

E.—GENERAL DESCRIPTION OF THE METHOD OF SOUNDING, TAKING SERIAL TEMPERATURES, SPECIFIC GRAVITIES, AND A HAUL OF THE TRAWL.

Having explained the apparatus in use on board the Albatross for deep-sea exploration, a general description of the operations at a single station will be given. We will suppose the depth to be about 1,000 fathoms, scope of dredge rope 1,500 fathoms, wind and sea moderate.

If the working reel is still in its tank it should be suspended and allowed to drain at least a half-hour before being mounted on the machine. We suspend it in its own tank by laying two strips of wood across the top and resting the axle on them, the lower part of the reel being an inch or two above the surface of the oil.

The officer of the deck warns the engineer of the watch half an hour before a station is to be occupied in order that the fires may be regulated. He then makes the necessary preparations on deck; has the reel mounted and the Sigsbee sounding machine rigged for use, the trawl mounted, bridle stops put on, wing nets adjusted, trawl net lashed (the ends of the bridle being made fast by the same lashing), and the mud bag secured to the eyes in the end of the bridle. If the trawl is dry a 27-pound weight is usually included with the mud bag. He has the dredging blocks overhauled and oiled, the register for the dredge rope adjusted, the hoisting and reeling engines oiled and prepared for use, the topping-lift shackled to the dredging boom, and the guys hooked. The end of the dredge rope which is on the drum of the reeling engine on the berth deck, Plate XXIV, is rove through the guide, thence forward through the leading-block, Plate II, Fig. 4, and under the governor pulley, 108, to the large winch-head of the hoisting engine on the upper deck, 40. Five turns of the rope are then taken around the winch-head, and the end carried aloft and rove through the accumulator block, Plate XLII, thence under the register pulley in the heel of the boom and through the dredging-block at the boom end. A thimble is then spliced in and the rope shackled to the trawl.

The boom is then topped up to an angle of about 50°.

When the vessel reaches the intended station the officer of the deck stops her with her stern to the wind, has the patent log hauled in, and then takes his station on the grating at the sounding machine, where he superintends the sounding, and maneuvers the vessel to keep the wire vertical during the descent. Having satisfied himself that the specimen cup is properly bent to the stray line, the sinker adjusted, the thermometer and water bottle clamped, the friction rope properly attended by a careful man detailed for the purpose, a man forward of the machine at the brake, one abaft it with the crank shipped, and another on the grating to attend the guide pulley, he will lower away gently until the apparatus is under water, then seize the small lead to the stray line, caution the record keeper to look out, have the pawl thrown back and the crank unshipped, and order "Lower away!" The speed of descent is regulated by him, and the record keeper reports and records the time at every 100 fathoms, the average being about 1^m 8^s with a 30-pound sinker, which would be used in the depth mentioned above.

The navigator determines the position. As soon as the sinker reaches bottom the reel is stopped by the friction rope, the record keeper notes the number of turns indicated by the register, the men stationed at the right and left of the machine ship the cranks and heave in a few turns to clear the specimen cup from the bottom, then throw the pawl into action, unship the cranks, unreeve the friction rope, and throw the belt on and set it up by means of the tightening pulley and belt tightener. A fireman, or machinist, has in the meantime prepared the reeling engine and shipped the ratchet crank on the crank shaft. When all is ready, and after the thermometer has had time to record the bottom temperature, the throttle is opened gradually, the engine being assisted over the centers with the ratchet crank, until a uniform speed is attained. The wire is reeled in at the rate of 100 to 125 fathoms per minute, each 100 fathoms being reported and the time noted by the record keeper.

When the stray line appears above water the engine is stopped, the cranks shipped, and the remaining few fathoms reeled in carefully by hand, stopping first to take off the small lead, then the water bottle, which is unclamped by the officer and handed to the man at the guide pulley to be delivered to the medical officer, who either takes its specific gravity or carefully seals it in a bottle prepared for the purpose to be forwarded to the laboratory at Washington for analysis.

The officer then unclamps the thermometer, reads the temperature, which is verified by the record keeper, who resets the instrument and sends it to the pilot-house, where it is suspended from a hook provided for the purpose.

The specimen cup is next removed from the end of the stray line and sent to the laboratory, where its contents are examined by a naturalist who informs the record keeper of the character of the bottom to be entered in his book. The officer of the deck makes this examination himself at times when the naturalists are otherwise engaged.

As soon as the specimen of ocean soil is removed the cup is carefully rinsed in water and adjusted for use.

A small portion of each bottom specimen is preserved in a vial whenever we are working on new ground, or if anything unusual is discovered, and at the end of each season the specimens thus collected are sent to the laboratory at Washington.

SERIAL TEMPERATURES AND SPECIFIC GRAVITIES.

As soon as the wire is in, the wind is brought a trifle on the starboard quarter by stopping the port engine and backing slowly on the starboard, turning ahead on the port if necessary.

There are two cast-iron sinkers provided for the temperature rope, one 520 and the other 150 pounds weight. One of these is shackled to the end of the dredge rope, swung over the side, and lowered a fathom or two under water, to steady it, the boom being rigged in until the rope rests against the side, inclining a little inboard above the rail.

The vessel having been placed in position, a thermometer and water bottle are sent to the officer of the deck, who clamps them to the temperature rope, the former lower down, in order that, in capsizing to register the temperature, there will be no danger of its striking the water bottle. The navigator sets the valves of the water bottles, and examines the thermometers before they are sent out.

The dredging boom is swung out far enough to clear the rope from the ship's side, and 100 fathoms veered, another thermometer and water bottle clamped on, and the operation repeated to 800 fathoms; the next and last 100 fathoms has instruments at 50 and 25 fathoms.

When sufficient time has elapsed for the thermometer at 25 fathoms to take the temperature the rope is reeled in and the boom swung in as the instruments appear above the rail. The officer of the deck unclamps the thermometer and reads it, then hands it to the record keeper who verifies the reading and notes it, as well as the number of the instrument, in the record book. The boatswain's mate of the watch unclamps the water bottle and delivers it to the surgeon or apothecary, who disposes of it as before mentioned. The instruments are rinsed in fresh water and returned at once to their proper receptacle.

The process is repeated as each pair of instruments reaches the surface until they are all on board, when the sinker is removed and the trawl shackled to the dredge rope. The rate at which the instruments are lowered and hoisted is from 50 to 75 fathoms per minute, depending somewhat upon the state of the sea.

It may not be out of place to mention here the care with which the temperatures are read when the deep-sea thermometers are used. It is well known that an error of parallax arising from the thickness of the thermometer tube is liable to occur; and, in order to reduce it to the minimum, the writer devised a sight block, which is simply a piece of close-grained wood an inch and a half in length, an inch wide, and

three fourths of an inch thick. A score is cut on one end which conforms in shape to the outside of the metal case inclosing the thermometer. To read the thermometer (Negretti and Zambra's) hold it at the height of the eye and toward the strongest light. Place the score of the sight block against the metal case, below the point of reading, and raise it carefully until the line of sight corresponds exactly with the upper surface of the block and the top of the column of mercury in the tube, when the temperature may be read with much greater accuracy than could be attained without the block.

DREDGING OR TRAWLING.

As soon as the sinker is on board, the port engine is started with a caution to the engineer of the watch to "Go slow for dredging!"

The vessel will naturally swing to starboard, which she is allowed to do until the intended course is reached, the wind on the starboard bow, or abeam, being the most favorable if it is intended to steam ahead while dredging.

In the meantime the trawl has been hoisted to the boom end and swung out ready for lowering as soon as the vessel is steadied on her course. It is first landed on the surface of the water and held there until the frame assumes a horizontal position, the net extending aft, at full length, the mud bag floating clear of the bridle ends, and the wing nets towing aft and clear. Then the order is given, "Lower away!" The speed of lowering is regulated by the record keeper, who stands, watch in hand, ready to check or increase the rate of descent, which is never allowed to exceed 25 fathoms per minute in depths over 300 fathoms. The machinist attending the hoisting engine calls out each 100 fathoms, so that the officer in charge knows at all times the amount of rope out.

The port swinging boom is rigged out and towing nets put over as soon as the vessel is steadied on her course, the speed for dredging (about 2 knots per hour) being admirably adapted for surface work. The nets are in charge of a man detailed from the crew, who works under the direction of a naturalist.

While the trawl is being lowered the officer in charge watches the angle of the rope, regulating the speed to keep it between 30° and 60° . He notes the trend of the rope also, whether it is toward or from the ship, and in the former case changes the course a trifle to starboard, which tends to carry it from the side. It frequently happens that the vessel will not steer with the port engine turning at a speed of 2 knots or less, especially after much rope has been veered out. In this case the starboard engine is started and the port one stopped. There is no difficulty while the starboard engine is in motion, as the inclination to turn to port is counteracted in a great measure by the drag of the trawl. This engine would be used at all times when steaming ahead were it

not for the danger of the trawl or dredge rope fouling the propeller before they sink below the surface.

The angle of the rope will gradually decrease as the trawl descends, and if it is 60° at starting it should be about 40° when the limit of 1,500 fathoms is reached. Should it exceed that angle after the engine has been running "dead slow," as may happen with a current in the direction of the course, it is advisable to stop until the angle is between 30° and 35° , then move ahead slowly with the same engine, regulating the speed so as to keep the angle between 35° and 40° . If there is no current the requisite speed will be readily attained with the engine; but if there should be a current with the wind, and the lowest speed attainable be too great, the engine should be stopped and the vessel allowed to drift, the rate being increased, if desirable, by the use of sail. In exceptional cases we have found it necessary to retard the drift by backing one of the engines.

The accumulator is watched closely after the trawl is landed, and any increase in weight is carefully noted. Should the increase be gradual and not excessive, the trawl is undoubtedly performing its functions normally; but a sudden addition of 2,000 or 3,000 pounds indicates that the trawl has either encountered some obstacle or buried itself in the soft ooze of the ocean bed. In either case instant relief is required and is received, first, from the hoisting engine, which, having its friction lever properly set, allows the dredge rope to run out when the limit of safety is reached; then the engine is stopped and reversed, and, as soon as the headway is checked, preparations are made for heaving in.

The vessel is then backed slowly toward the trawl, the slack rope reeled in, keeping a tension on it equal to or somewhat greater than the weight of rope out, in order to guard against slack which would result in kinks. In this manner the vessel will be placed directly over the trawl and the rope hove short. If the trouble has arisen from an ordinary obstruction it can be cleared usually by backing in the opposite direction from which it was laid out. Should this maneuver fail it is pretty safe to conclude that the trawl has buried, and in this case we heave in until we reach the limit of safety and allow the vessel to ride by the rope until the tension decreases; then heave again, until the trawl is gradually worked out of its bed. We then steam ahead slowly, washing the mud from the net until it can be hove up safely.

Should all efforts fail to clear it, as sometimes happens, we make everything fast and steam ahead until either the bridle-stops part and the trawl comes up tail first, or the rope parts, the trawl and its attachments being lost.

The most trying position is when we get an overload of stones, clay, or tenacious mud which will not wash through the meshes of the net, and must be hove up with the greatest care, consuming hours of valuable time, and not infrequently parting the bridle-stops or the rope just

as the trawl heaves in sight, losing the entire contents or the trawl itself, as the case may be.

Supposing everything to have worked satisfactorily and the trawl been dragging half an hour, the order is given to get ready for heaving. The hoisting engine is moved to work the water out of the cylinders, and the moving parts are oiled. The reeling engine is likewise put in readiness, the guide connected, and the governor brought into action. Everything being ready the order is given to heave away, and the rope reeled in at the rate of 25 fathoms per minute, the vessel being allowed to retain her headway until the trawl is known to be well clear of the bottom.

This is done for the double purpose of avoiding the danger of the trawl settling in the mud if allowed to remain stationary for any length of time, and to prevent fish or other specimens which have not already found their way to the pocket from floating or swimming out of the mouth of the trawl.

The speed at which it is hove up is varied according to circumstances, not exceeding 30 fathoms per minute under the most favorable conditions when the specimens are from a greater depth than 500 fathoms; although in shoal water a speed of 35 fathoms per minute is at times admissible. The machinist at the hoisting engine reports each 100 fathoms as in veering out, and the record keeper notes it in his book.

After the trawl is off the bottom and the engine stopped, the dredge rope will sometimes draw under the bottom, even though the vessel has her starboard broadside to the wind and is drifting rapidly. In this case we would back the starboard engine, go ahead on the port, and put the helm hard a-port, which would soon clear it. This trouble usually occurs in reeling in after the trawl has been laid out, steaming head to wind or backing stern to it, and the vessel has been allowed to fall off with the dredge rope to windward, a position which at first sight seems to be the proper one. Such is not the case, however, for the vessel is lying at right angles to her former course, and consequently with the rope trending under her bottom. If it is reeled in faster than the vessel is drifting, it will be drawn still more closely under the keel.

If the trawl has been laid out against the wind, heave to with the dredge rope to leeward, when the drift will assist the operation of reeling in. It should be borne in mind, however, that the vessel must be turned with the dredge rope to windward by backing the starboard and going ahead on the port engine before it draws under the bottom, which it will do as soon as the vessel has drifted over the position of the trawl.

When the trawl is up, the boom is rigged in until the bag swings against the ship's side, when a strap is passed around it and it is hoisted on board by means of a stay tackle. If the load is very heavy, the afterboom guy is used to help to get it over the rail, the lower block being hooked usually to the eye in the end of the bridle.

The mud bag is removed first, then the lashings taken off, and the

contents emptied into the table sieve. The naturalists then collect the specimens, the steam hose being used to wash the mud from them.

The trawl is lowered on deck after being relieved of its contents, the wing nets and trawl nets carefully attended to, the lashings replaced, bridle-stops examined or renewed, and everything made ready for another haul.

The vessel resumes her course as soon as the trawl leaves the water.

The handling of the trawl and the maneuvering vessel while trawling is under the personal supervision of the commander or executive officer.

The time consumed in sounding, taking serial temperatures, and a haul of the trawl as described is about three and one-half hours.

F.—OTHER APPARATUS.

The fishing gear, collecting apparatus, and laboratory outfit are quite extensive. The following summary includes the most important articles:

FISH LINES RIGGED FOR USE.

- 12 squid lines.
- 10 whiting lines.
- 2 boat-cod hand-lines, 2-pound leads.
- 2 boat-cod hand-lines, 3-pound leads.
- 2 boat-cod hand-lines, 4-pound leads.
- 5 red snapper lines.
- 5 bluefish lines for trolling.
- 4 sea-bass lines, style used in Southern States.
- 4 sea-bass lines, style used by New York smackmen.
- 5 bluefish lines for still-baiting.
- 1 shark line.
- 8 skates halibut trawl line.
- 4 tubs haddock trawl line.
- 60 mackerel hand-lines.

In addition to the lines ready for use, the laboratory contains a quantity of spare lines and a large assortment of hooks, sinkers, jigs, &c.

MISCELLANEOUS APPARATUS USED IN FISHING.

- | | |
|---------------------------|-----------------------------|
| Anchors, snug stow net. | Hooks, ice. |
| Anchors, snug stow trawl. | Hurdy-gurdy or trawl winch. |
| Baskets. | Jigs, mackerel. |
| Buoys, halibut trawl. | Jigs, squid. |
| Buoys, keg net. | Knives, codfish bait. |
| Compasses, dory. | Knives, codfish throating. |
| Fish forks. | Knives, dory. |
| Fish pew. | Knives, halibut bait. |
| Floats, covered glass. | Knives, mackerel splitting. |
| Gaffs, deck, cod. | Knives, oyster. |
| Gaffs, dory, cod. | Lance, shark-killer. |
| Gaffs, iron, halibut. | Lance, whale. |
| Harpoons, assorted. | Leads for net lead-line. |

Mill for grinding bait.
Mold for lead-line sinkers.
Mold for mackerel jigs.
Nippers, woolen.
Scoops, bait.
Scoops, ice.
Splicers, iron line.
Swivels, snood.

Swivels, slot.
Shovel, ice.
Sling ding spreaders.
Tubs, dressing.
Tubs, gib.
Whale gun.
Whale line.

NETS.

Kinds.	Length.	Depth.	Size of mesh.	Twine.
	Fath.	Fath.	Inches.	
Trammel net (2).....	15	2½	{ 2 6	35-3 12-16
Mackerel gill net.....	30	2½	3½	16-6
Do.....	30	2½	3	16-6
Do.....	30	2½	2½	16-6
Menhaden gill net.....	15	2	5½	16-6
Do.....	15	2	2½	16-6
Shad gill net.....	50	4	4½	35-3
Do.....	50	4	4½	35-3
Cod gill net.....	100	2	7	40-10
Do.....	100	2	8	40-10
Herring gill net (2).....	20	2½	2½	20-6
Do.....	20	2½	2½	20-6
Red snapper gill net (2).....	50	3	9	
Capelin seine.....	40	3½	{ 0½ 2½	12-6
Casting net.....				

DIP AND SCOOP NETS.

Kinds.	Bow diameter.	Handle length.	Number in outfit.
	Inches.	Feet.	
Dip nets for mackerel seine.....	29	10	12
Dip nets for torching, linen.....	23	7	12
Scoop nets with round bows for handling fresh fish.....	15	4½	6
Scoop nets with straight edge.....	14	4½	2

LABORATORY OUTFIT.

Antimony.
Arsenic.
Alum.
Acids, picric, chromic.
Anvil.
Brushes, water.
Bags, rubber.
Boxes, small assorted paper.
Boxes, nests, assorted.
Buckets.
Cloth, cotton cheese.
Clay for making casts.
Chisels, cold,

Chisels, mortising.
Cutters, wire.
Camera lucida.
Dippers, galvanized-iron.
Dippers, galvanized-iron, fine wire-cloth bottom.
Dishes, assorted, glass and earthenware.
Drills, twist, assorted.
Hammers, blacksmith's.
Hammers, riveting.
Hatchet.
Jars, with corks, eight sizes.
Jars, fruit, 1-pint, 1-quart, 2-quart.

Jars, butter, 2-pound, 4-pound.	Rule, millimeter.
Knives, cartilage.	Rule, common, 2-foot.
Knives, dissecting.	Rifle, 32 caliber.
Microscope, with accessories.	Shotguns, 12 bore (2).
Nets, surface, silk bolting cloth.	Shotguns, 10 bore (1).
Nets, surface, linen scrim.	Spades, trenching.
Nets, tub strainer, linen scrim.	Spades, common.
Paper, manilla.	Shovels, common.
Paper, straw.	Seives, assorted.
Paper, English white tissue.	Scissors.
Pans, large, galvanized-iron.	Tubs, wash, large size.
Potash.	Tanks, copper alcohol, in boxes, 17 16-gal-
Plaster for molds and casts.	lon, 20 8-gallon, 40 4-gallon.
Presser, cork.	Vise, hand.
Rings, galvanized-iron, surface net.	Vise, bench.
Rings, brass, surface net.	Vials, homeopathic, assorted.

THE LIBRARY.

The ship's library contains over 300 volumes. Under the head of natural history, &c., there are 58 volumes; scientific, 57 volumes; publications of the United States Fish Commission, Smithsonian Institution, and National Museum, 48 volumes; miscellaneous, 36 volumes; navigation and nautical astronomy, 19 volumes; history and biography, 18 volumes; steam, 6 volumes; &c.

It was the intention to provide such works as would be useful in all the branches of investigation carried on by the vessel, text-books and professional works required for reference by naval officers, besides a few standard volumes of history and biography.

REMARKS ON THE OUTFIT, MESS FURNITURE, ETC.

It is customary in the naval service to provide a recruit with bag and hammock free of charge, his mattress and blankets being furnished by the paymaster and charged to his account. This expense although not very serious for a three years' recruit assumes greater importance when the term is for one year only, as with us, and to avoid running the men in debt to that amount we have adopted the plan of supplying them with mattresses and blankets without charge, holding them responsible for their proper care while in use, and their return to the ship before they receive their discharge.

Mess furniture for the cabin, wardroom, and steerage was furnished by the Commission as the simplest solution of a rather complicated situation which may be briefly stated as follows:

The officers of the ship detailed from the naval service would be expected to furnish their own mess furniture, bed linen, &c., according to custom, but the Commission would be obliged to provide for the naturalists, from one to half a dozen, who come and go as occasion requires, as it would be obviously unjust to require the officers of the ship to furnish them with the necessary outfit. Even this arrangement would

prove unsatisfactory from the difficulty of properly apportioning the mess expenses, hence the necessity for the following plan which has worked to the satisfaction of all concerned :

The Commission furnishes the quarters and mess furniture complete, as stated above, and pays to the officers' mess the uniform sum of \$1 per day for subsistence of each person sent on board by competent authority. The same provision is made for them as for officers regularly attached to the vessel, and they are accorded equal privileges in the mess while temporarily attached to it.

G.—CO-OPERATION OF THE NAVY DEPARTMENT.

The officers and crew were furnished by the Navy Department in accordance with the act of May 31, 1880, and acting under Sec. 4397, act of February 9, 1871.

The Bureau of Equipment and Recruiting furnished anchors and chains, including mooring swivel, chain hooks, extra club link, spare shackles, implements, &c.

The Bureau of Navigation furnished 1 azimuth circle, 2 tripods, 2 liquid compasses, 1 set of navigation books, 1 set of charts, 1 hack chronometer, 1 course indicator, and 2 boxes of Very's night signals, with pistols, pouches, and frogs.

The Bureau of Ordnance furnished 1 3-inch B. L. rifle with complete outfit, including 75 charges of powder, 25 shells, 25 shrapnel, 50 boxer fuses, &c.; 6 Hotchkiss rifles with 1,200 cartridges, 9 revolvers and frogs, with 240 cartridges.





The Albatross dredging.



FIG. 1. PLAN OF POOP-HOUSE & FORECASTLE DECKS.

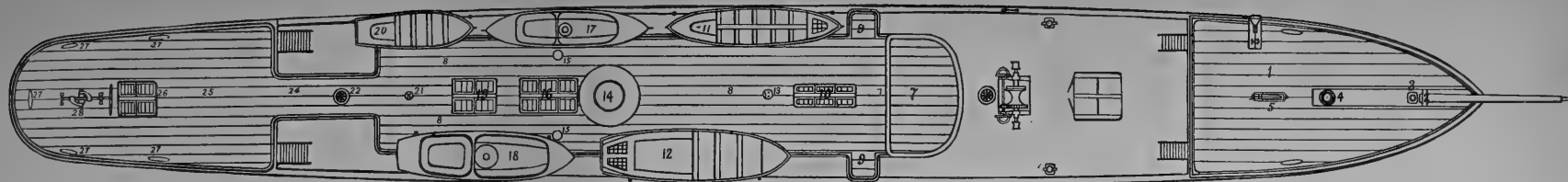


FIG. 2. PLAN OF MAIN DECK

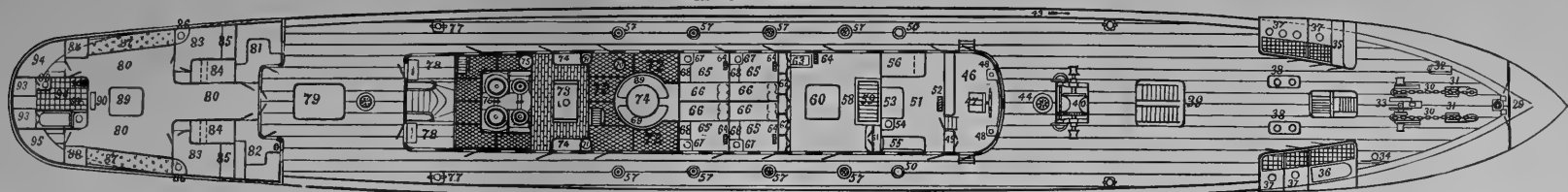


FIG. 3. PLAN OF BERTH DECK.

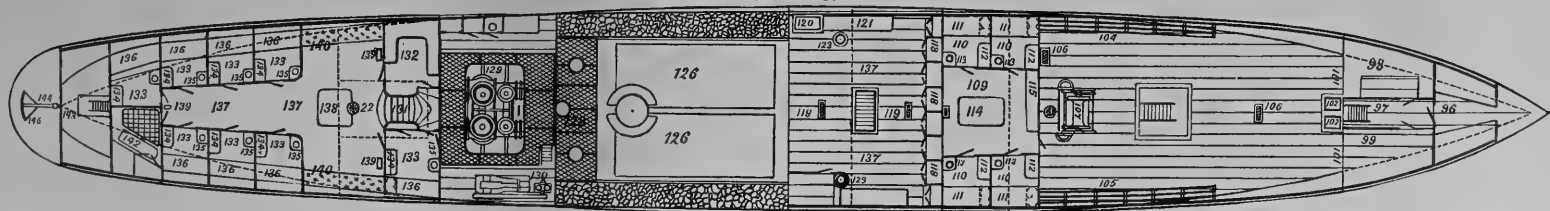
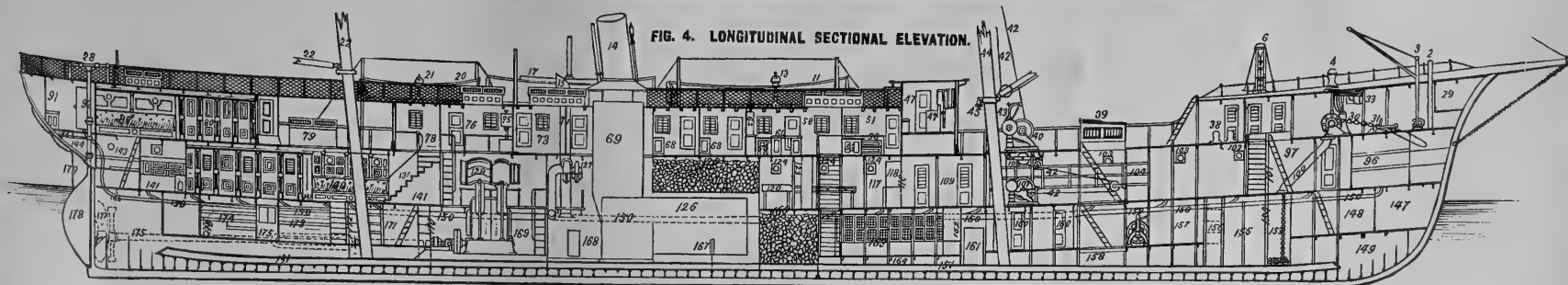
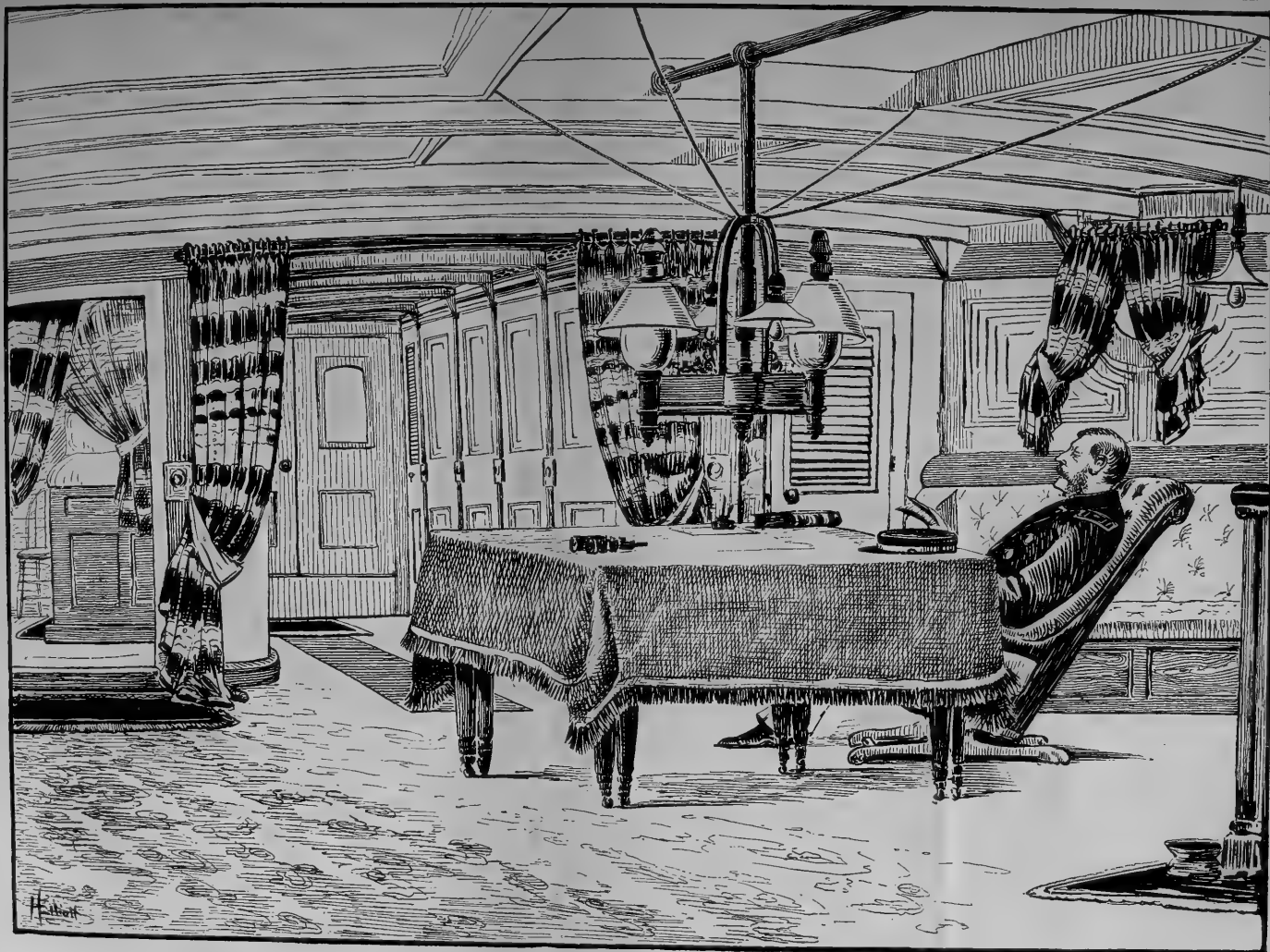
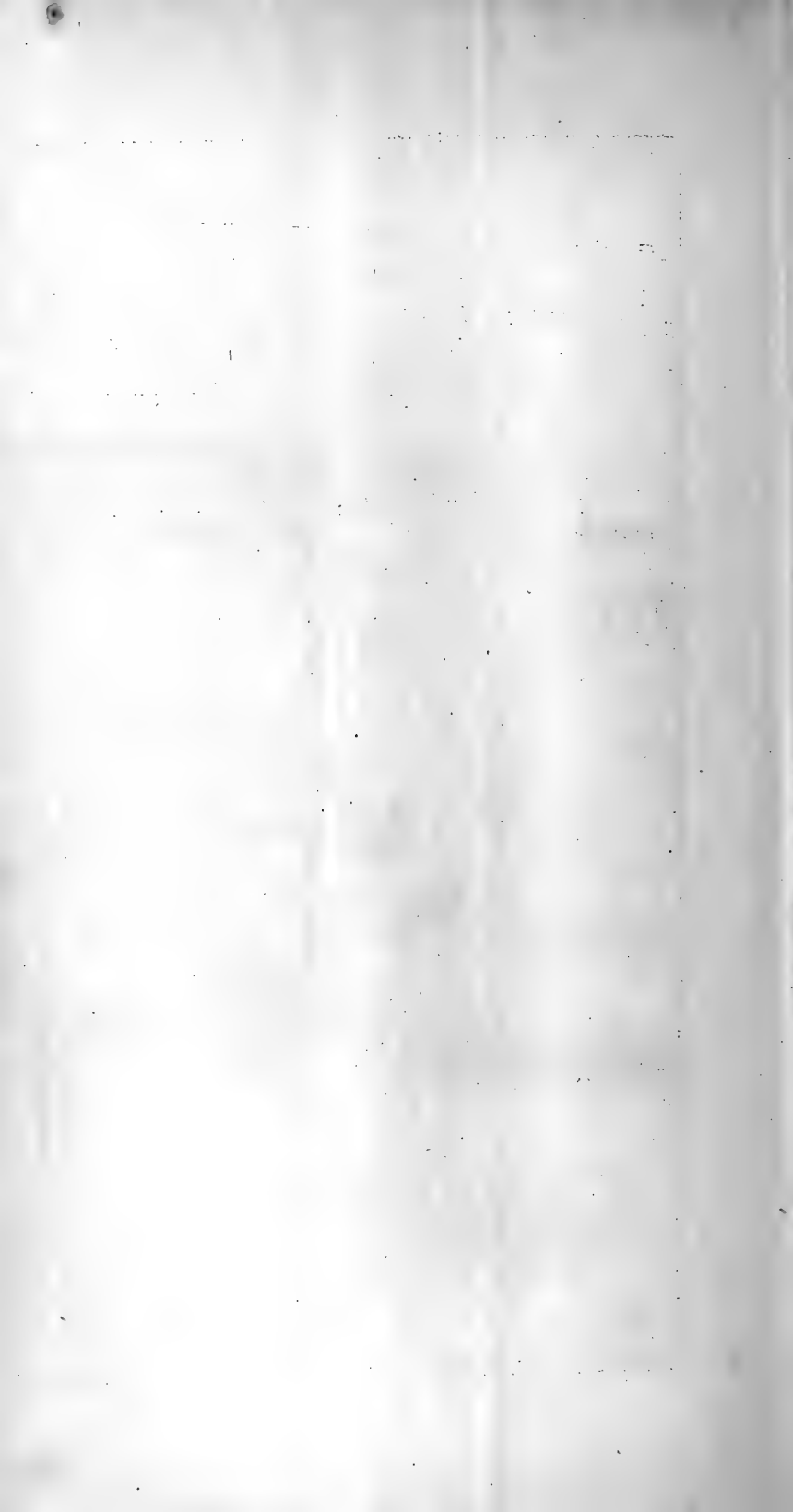


FIG. 4. LONGITUDINAL SECTIONAL ELEVATION.



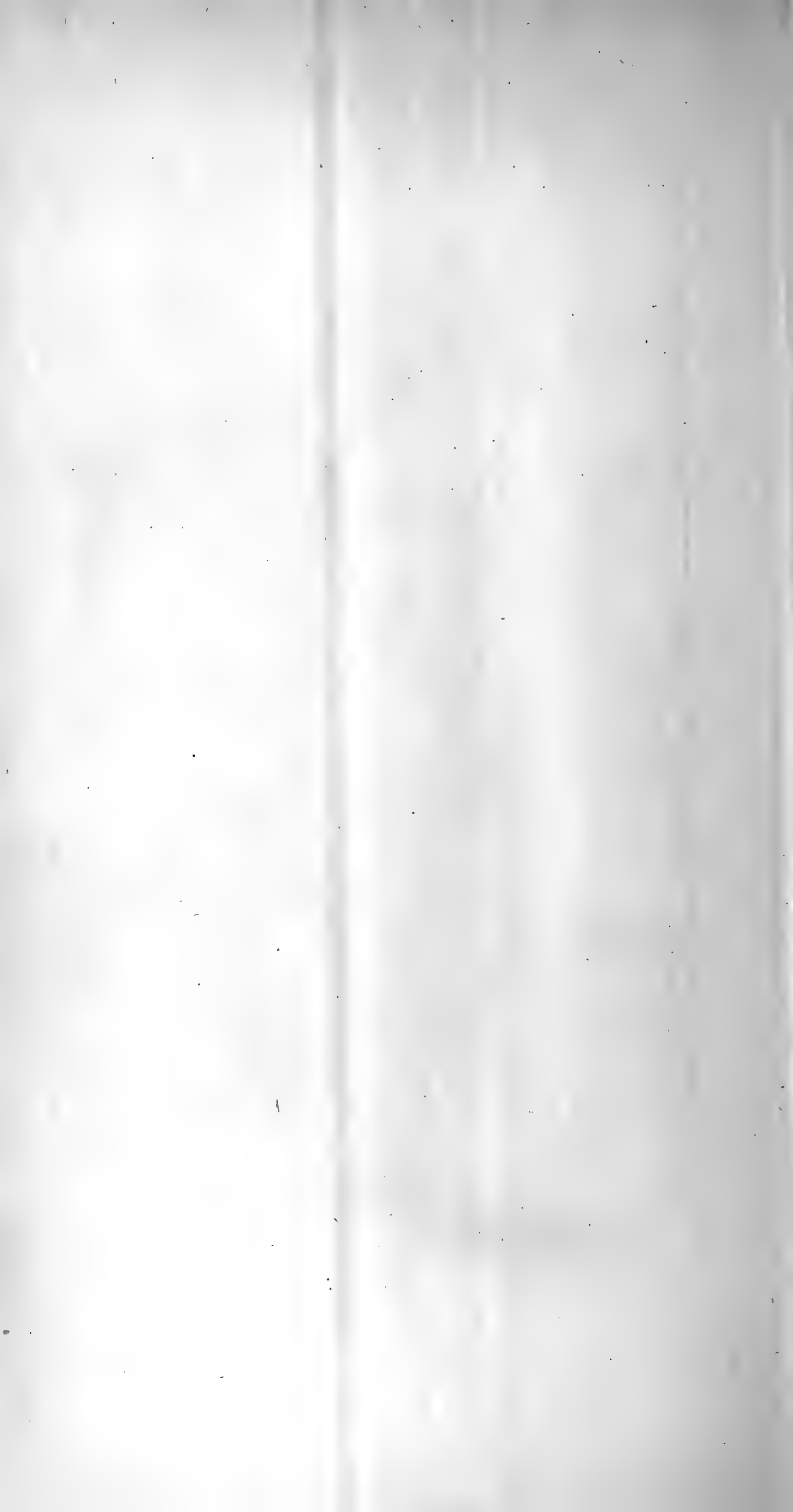


The cabin.



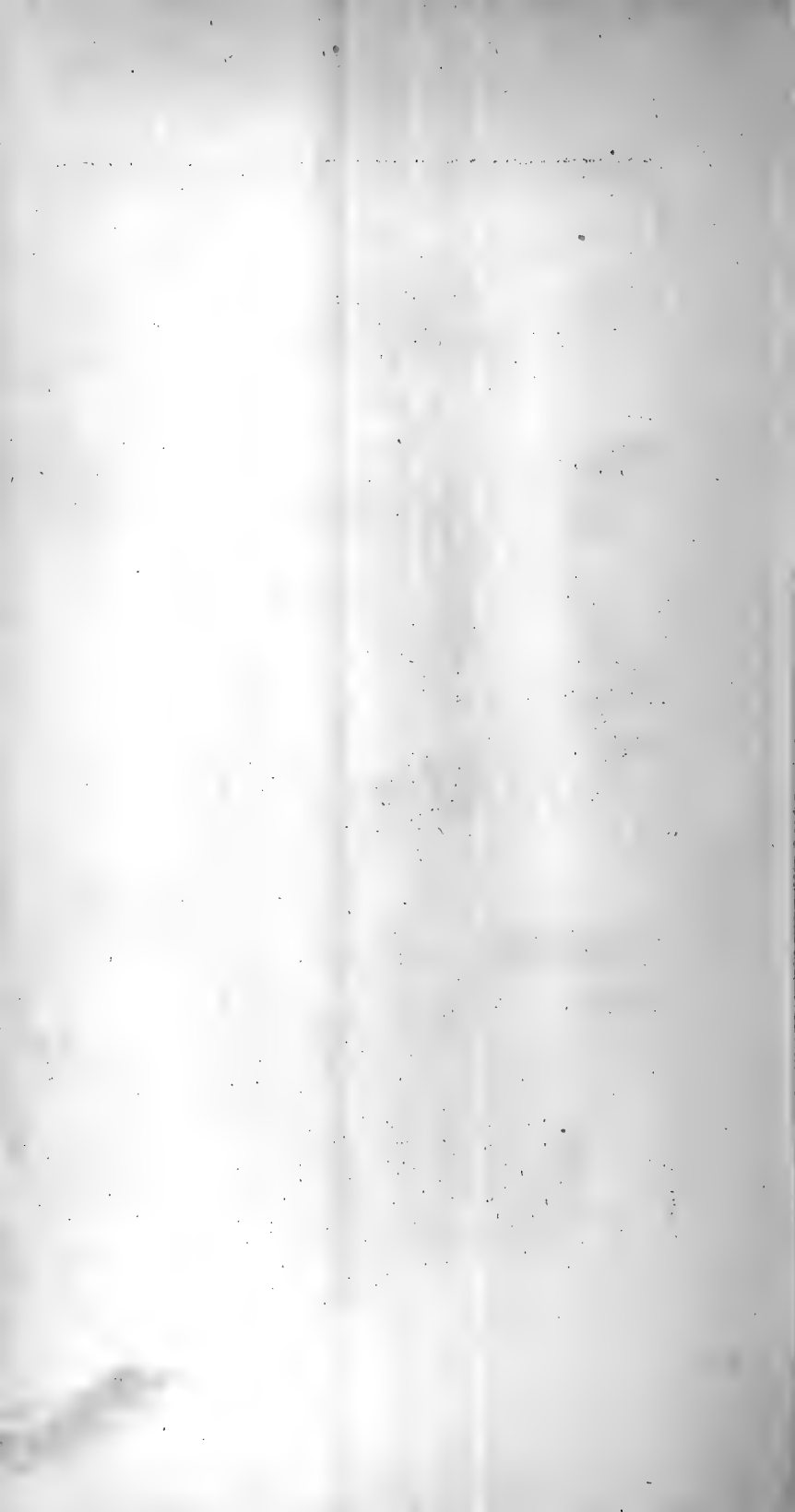


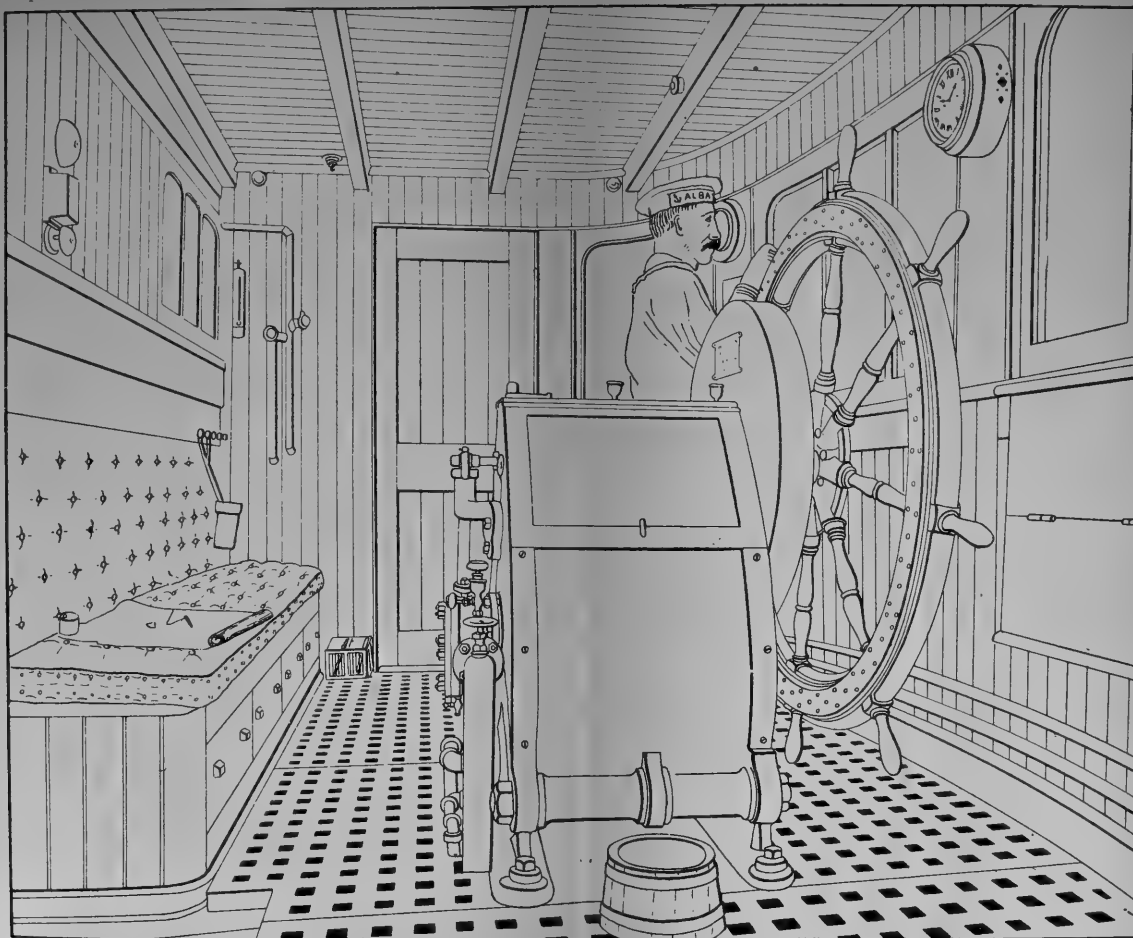
Upper laboratory.



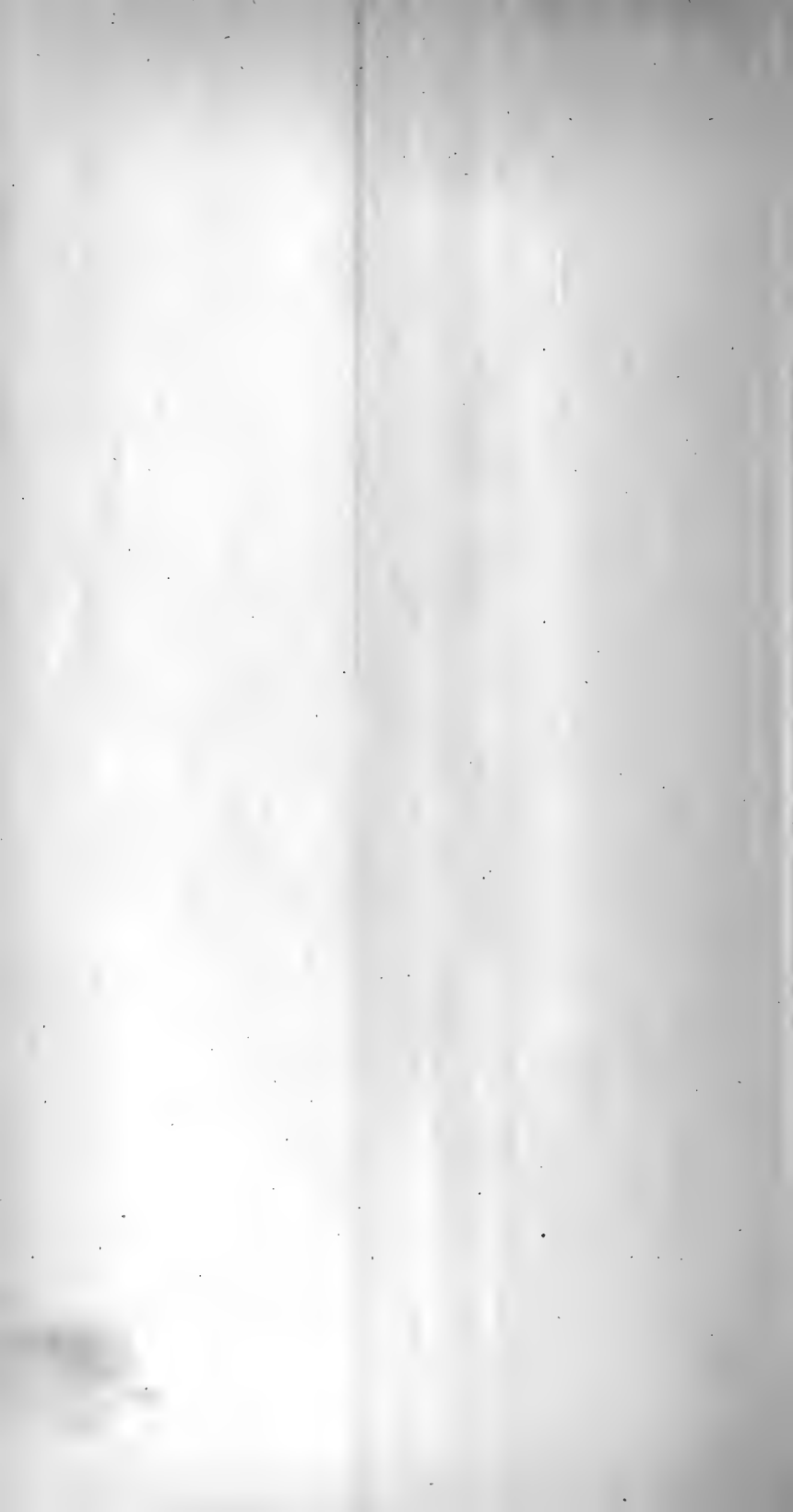


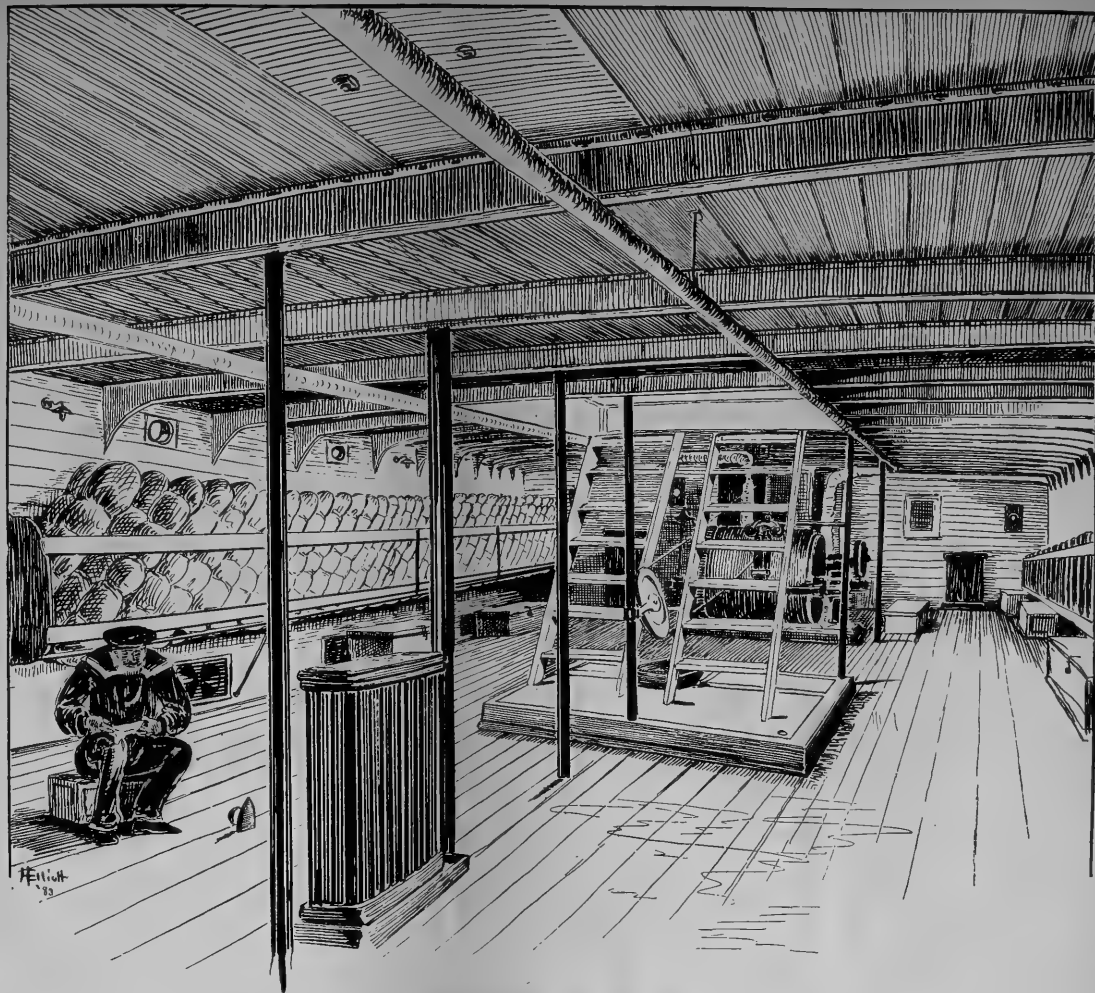
The chart-room.



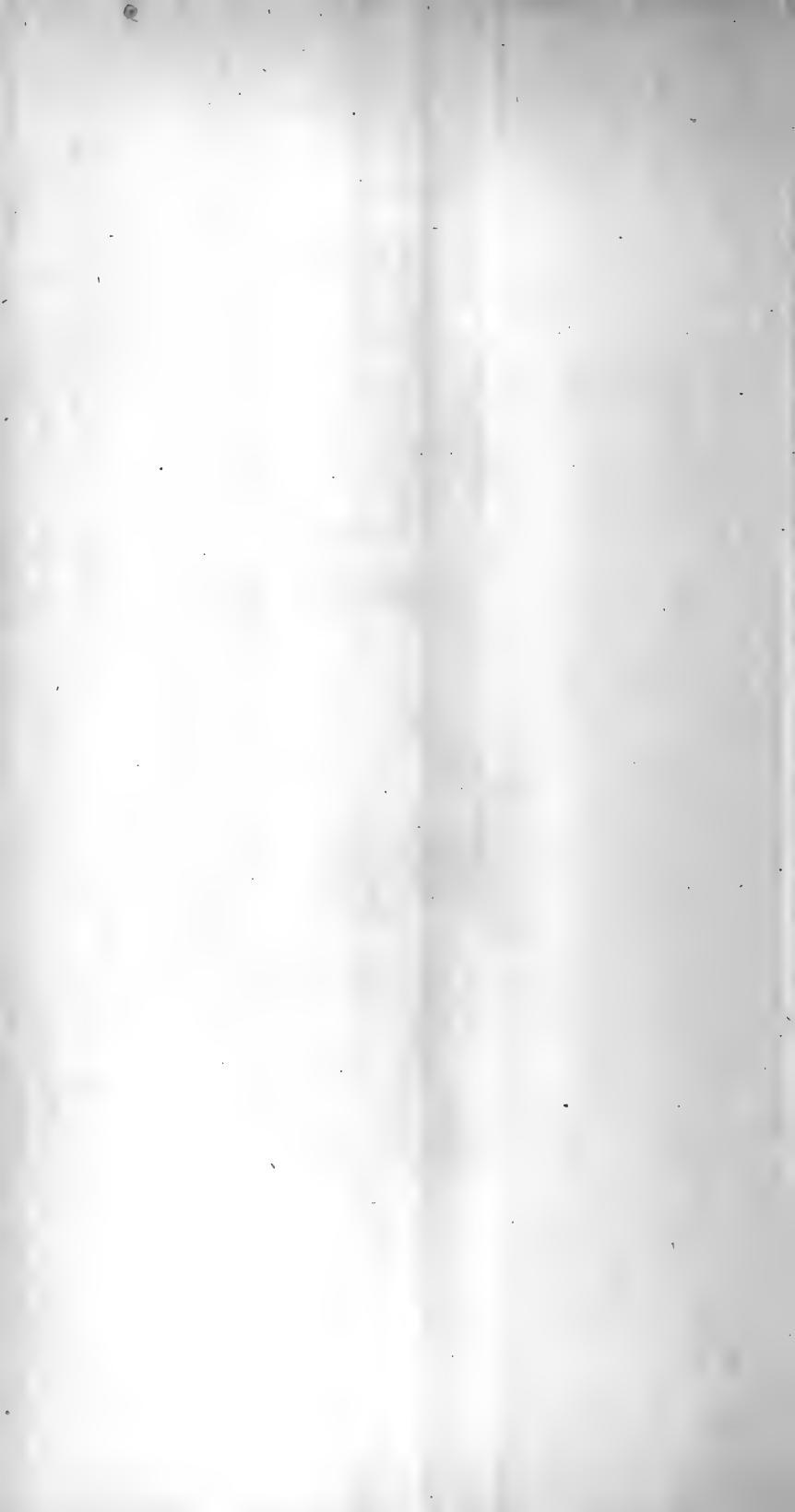


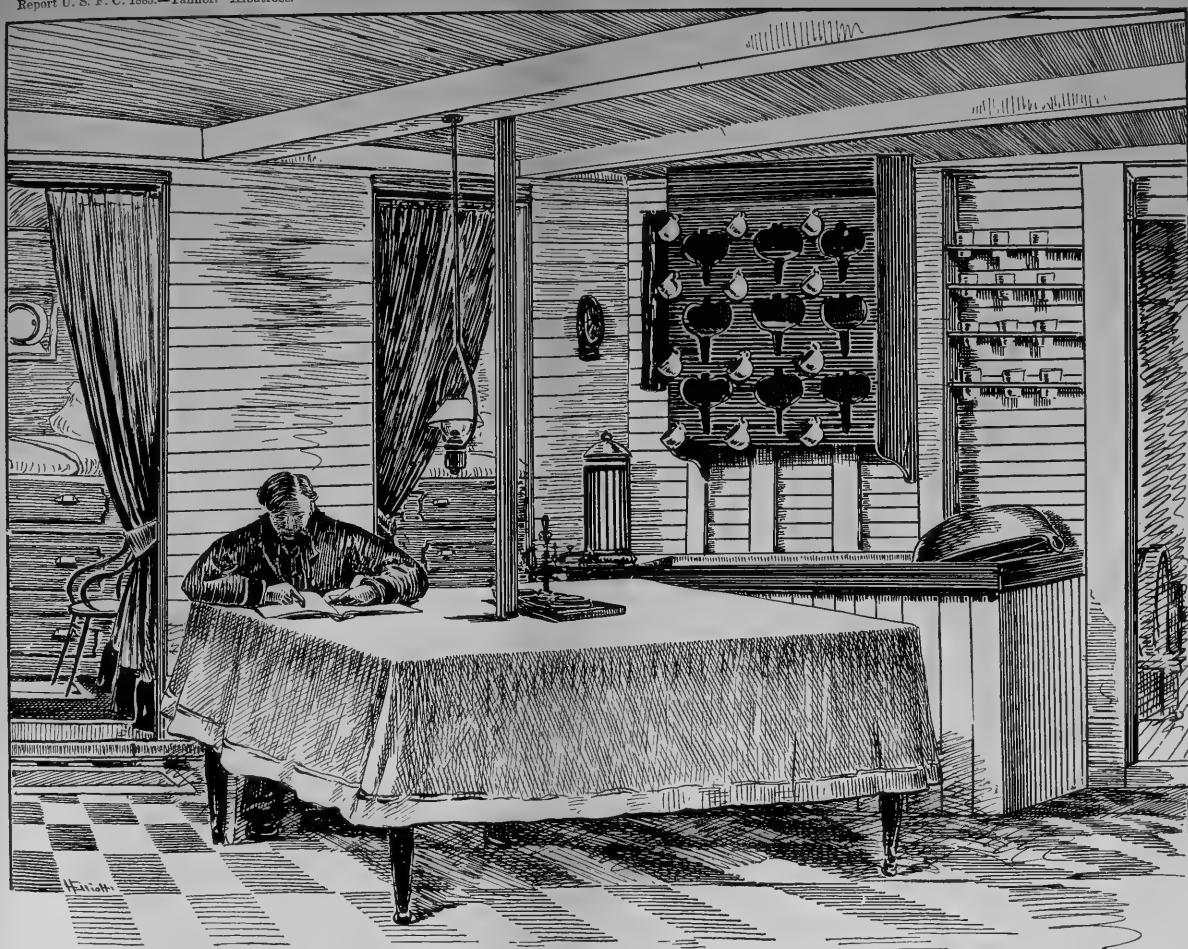
Interior of the pilot-house, steam steering engine.





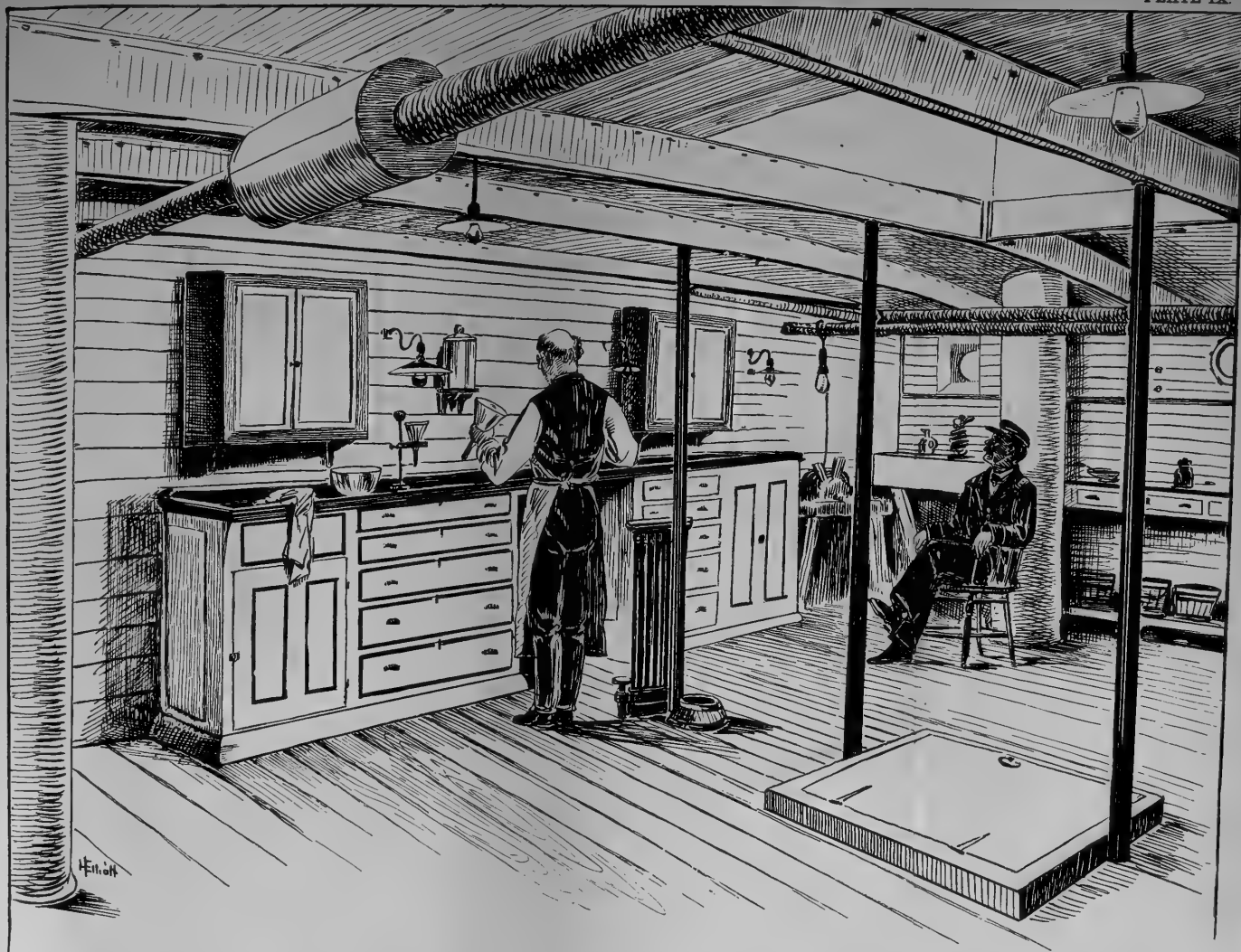
Berth deck, looking from forward aft.



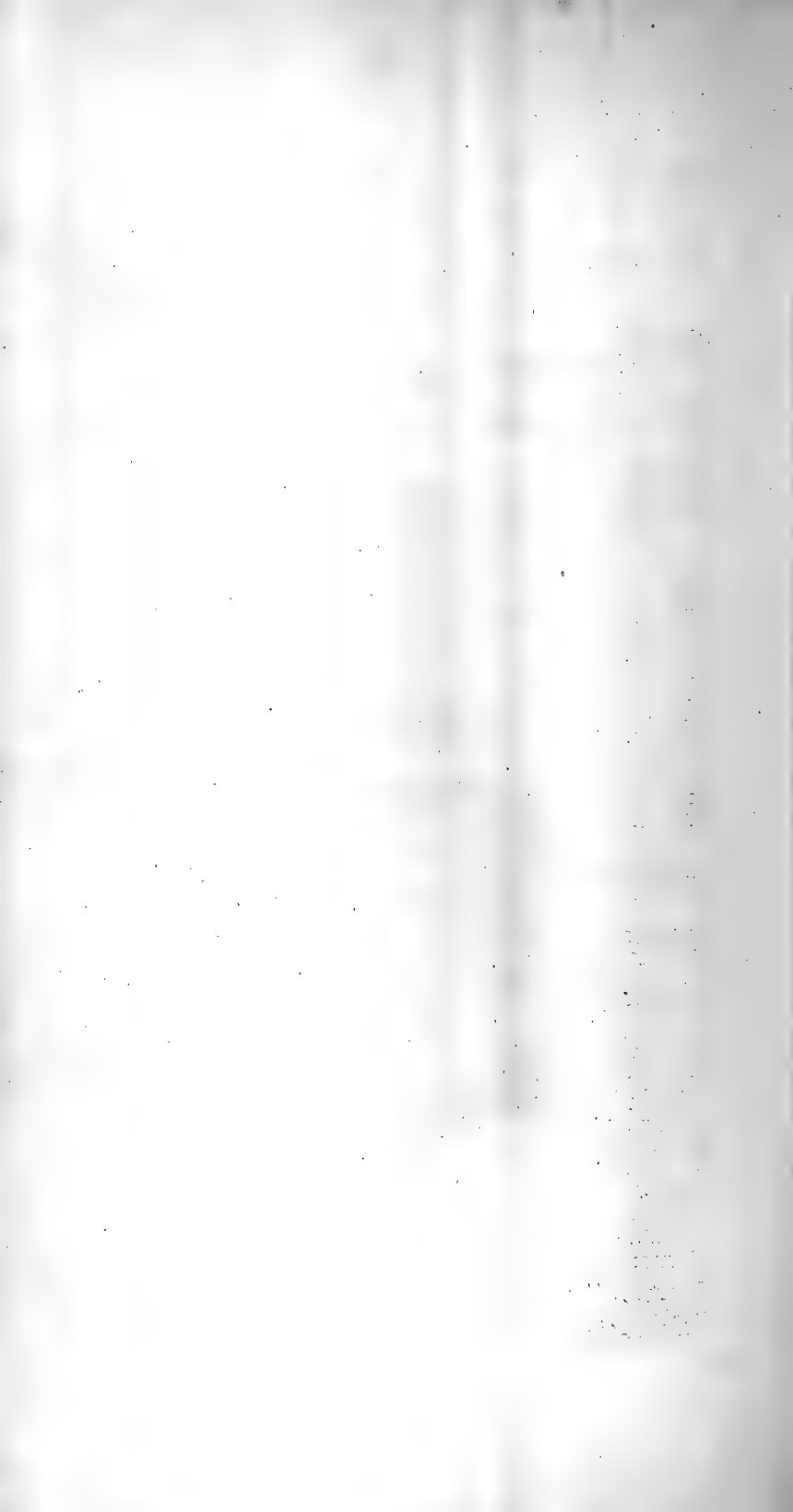


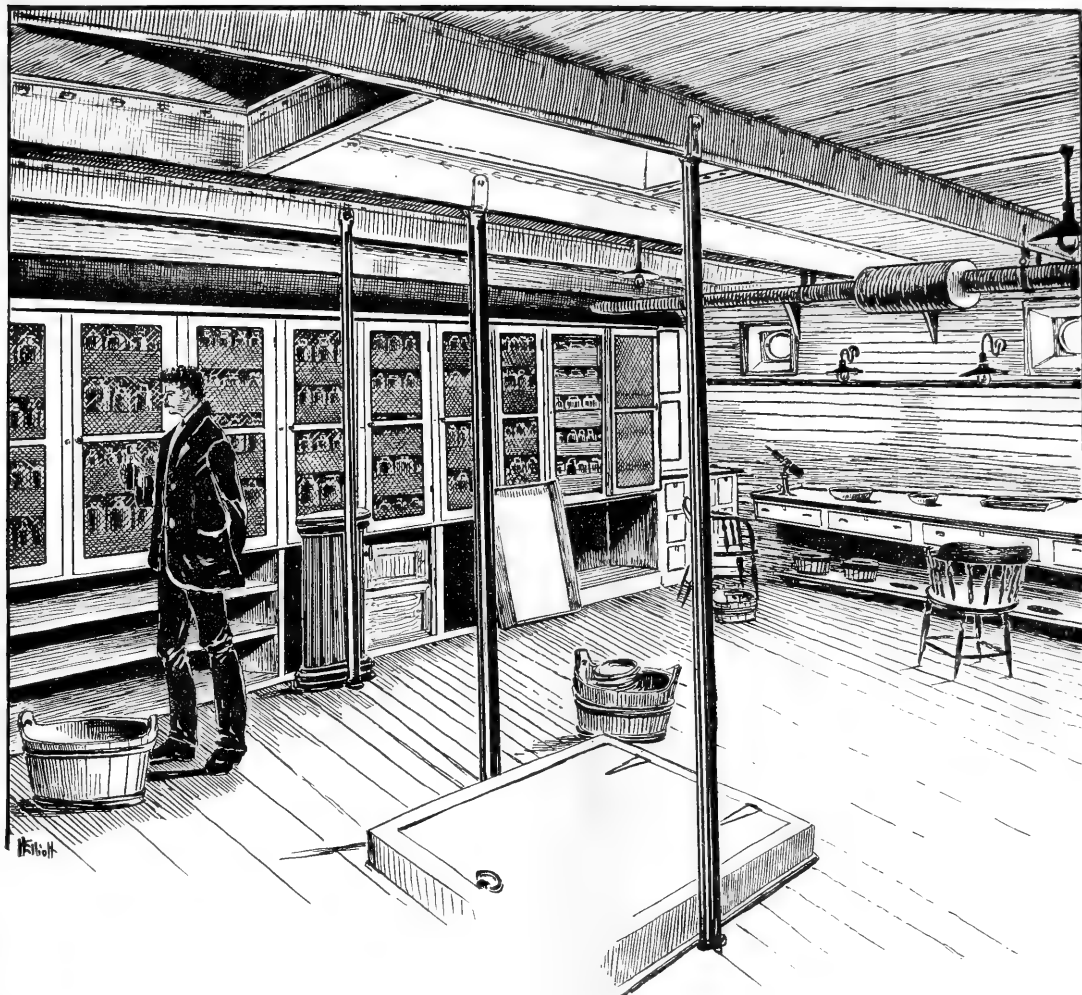
The steerage.



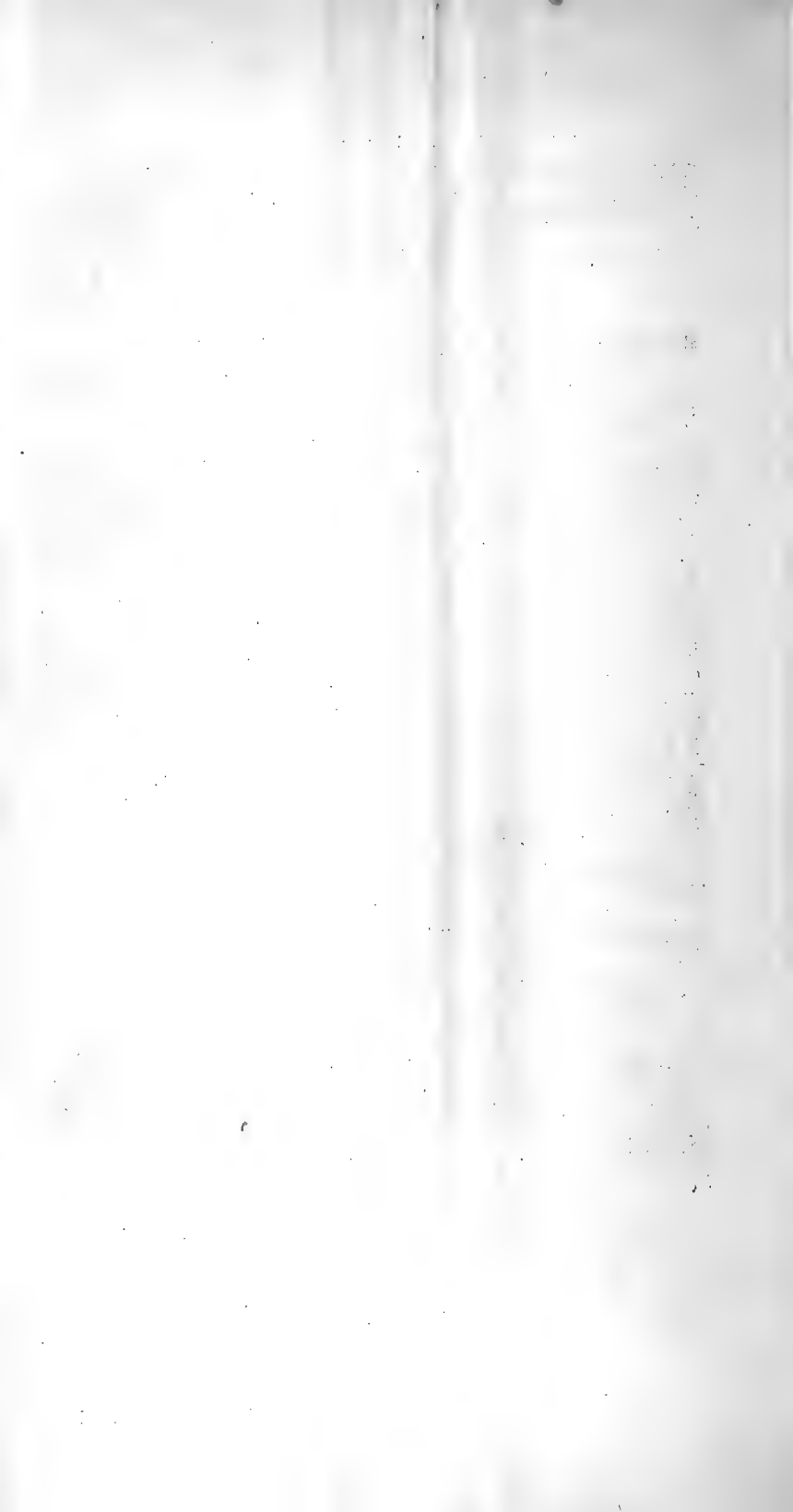


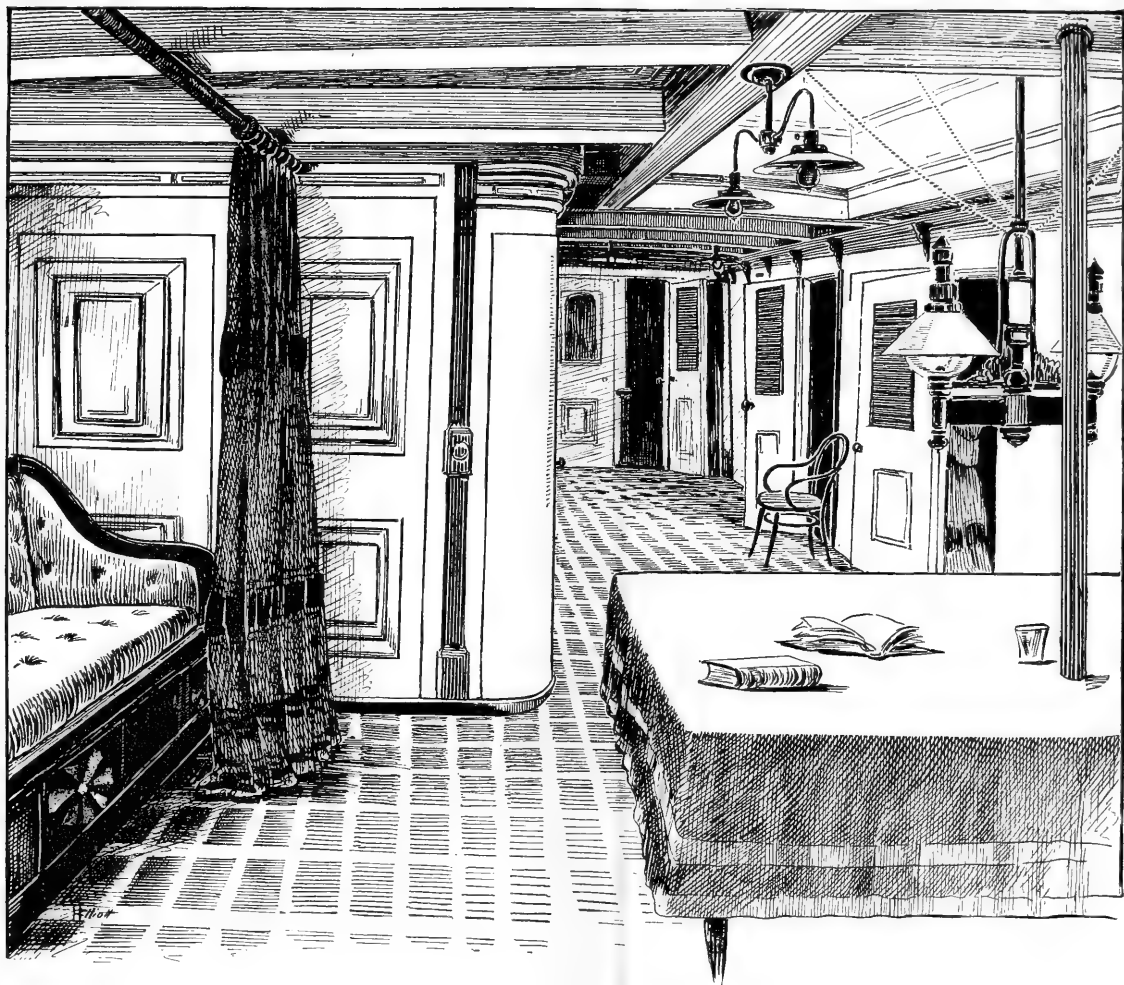
Lower laboratory, looking from forward aft.



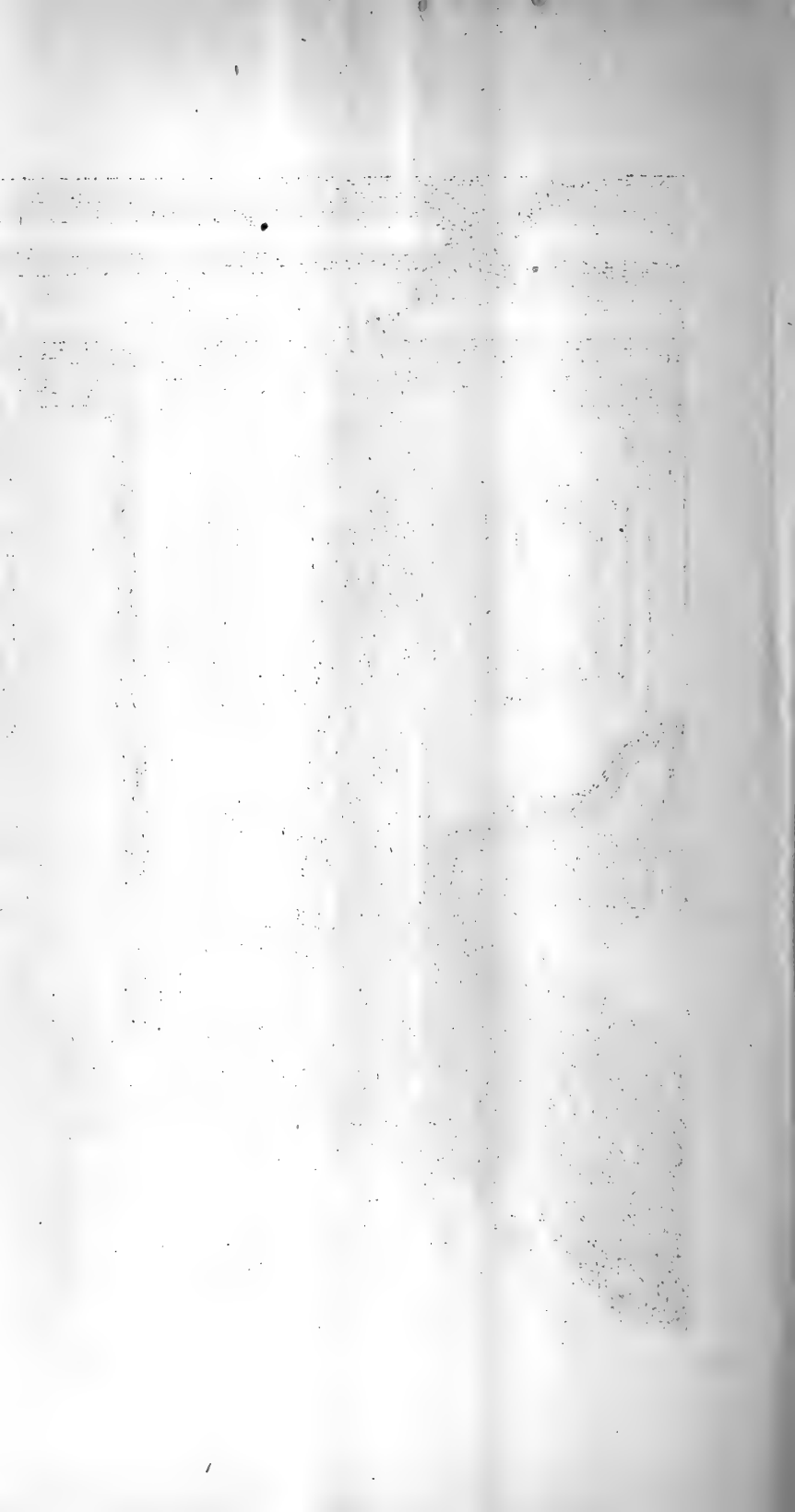


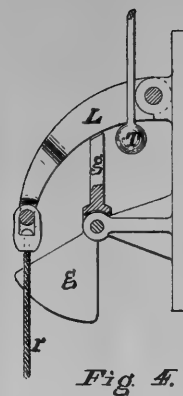
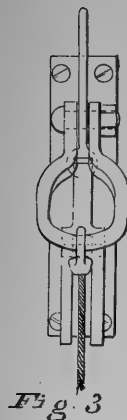
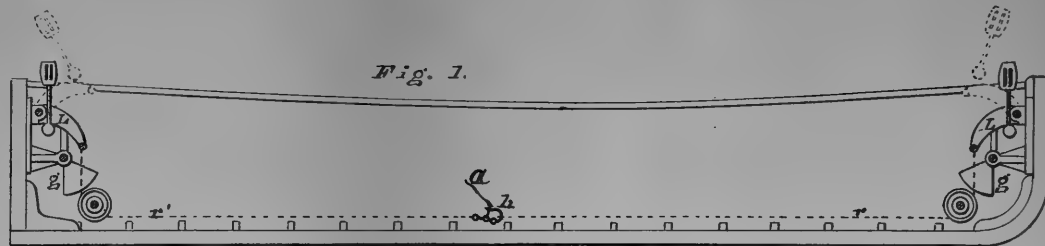
Lower laboratory, looking from aft forward.





The ward room.





Lieut. W. M. Wood's boat-detaching apparatus.

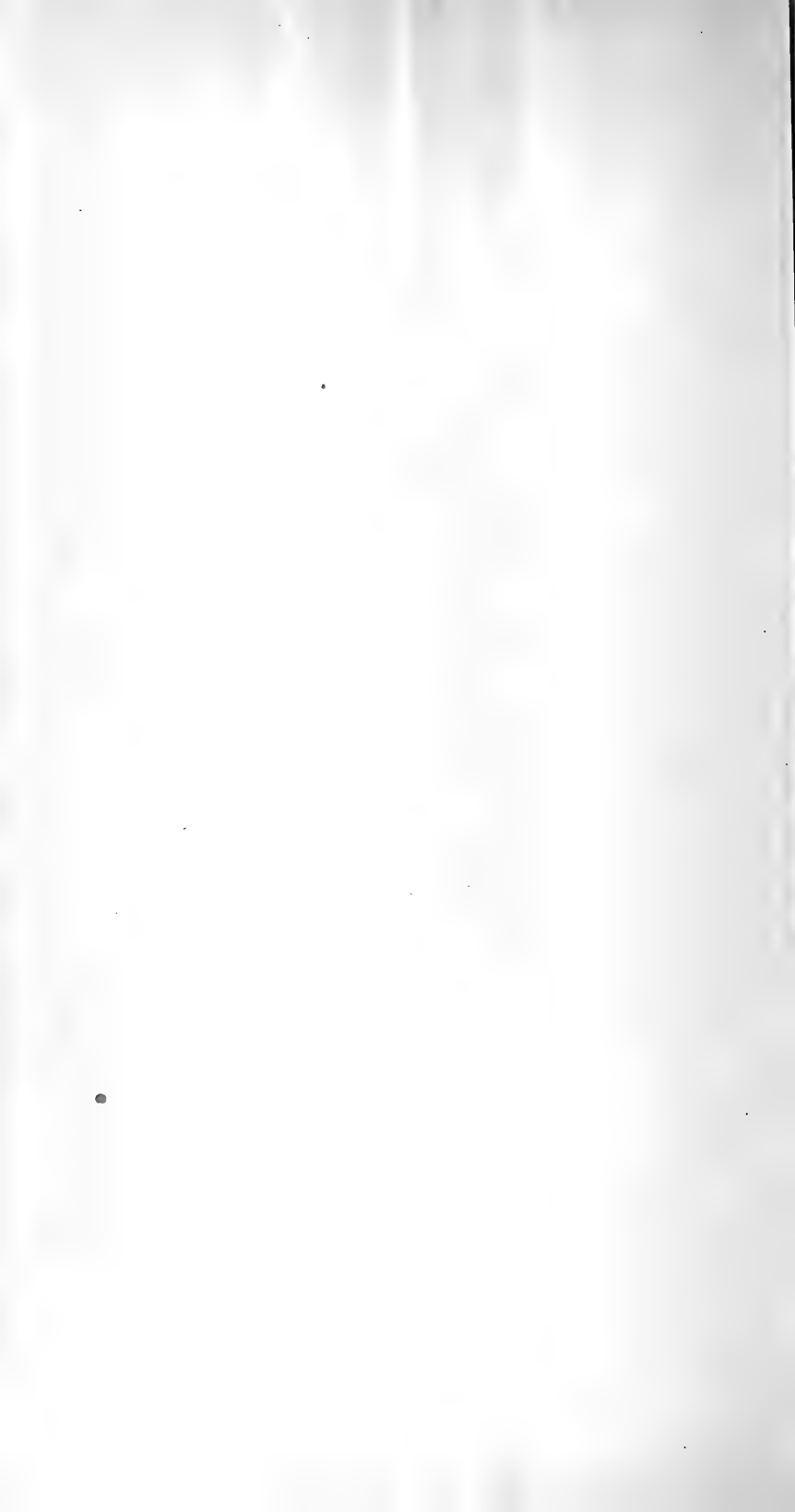


Fig. 1

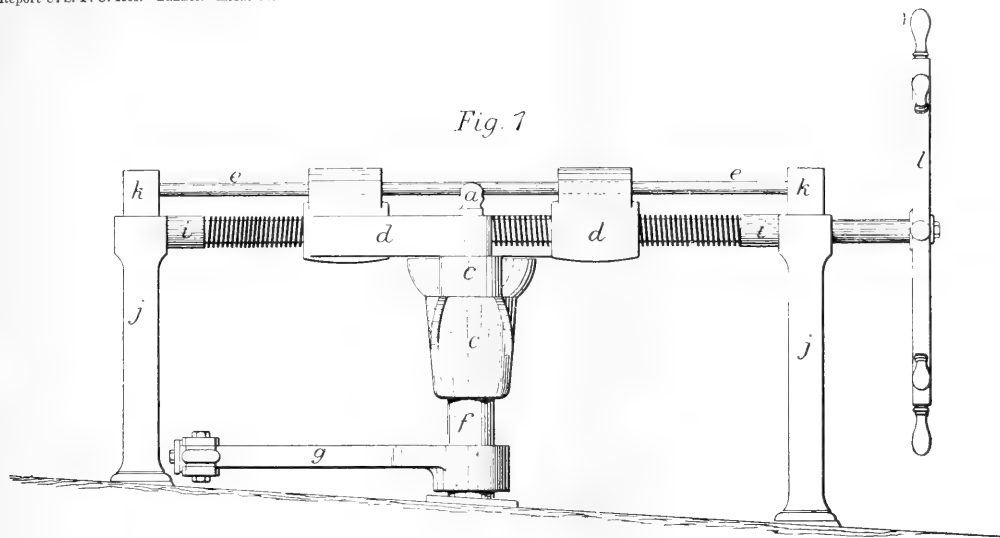
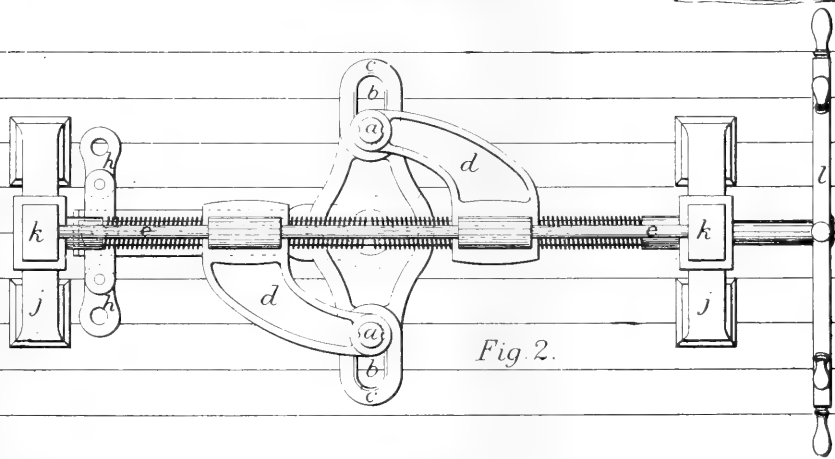
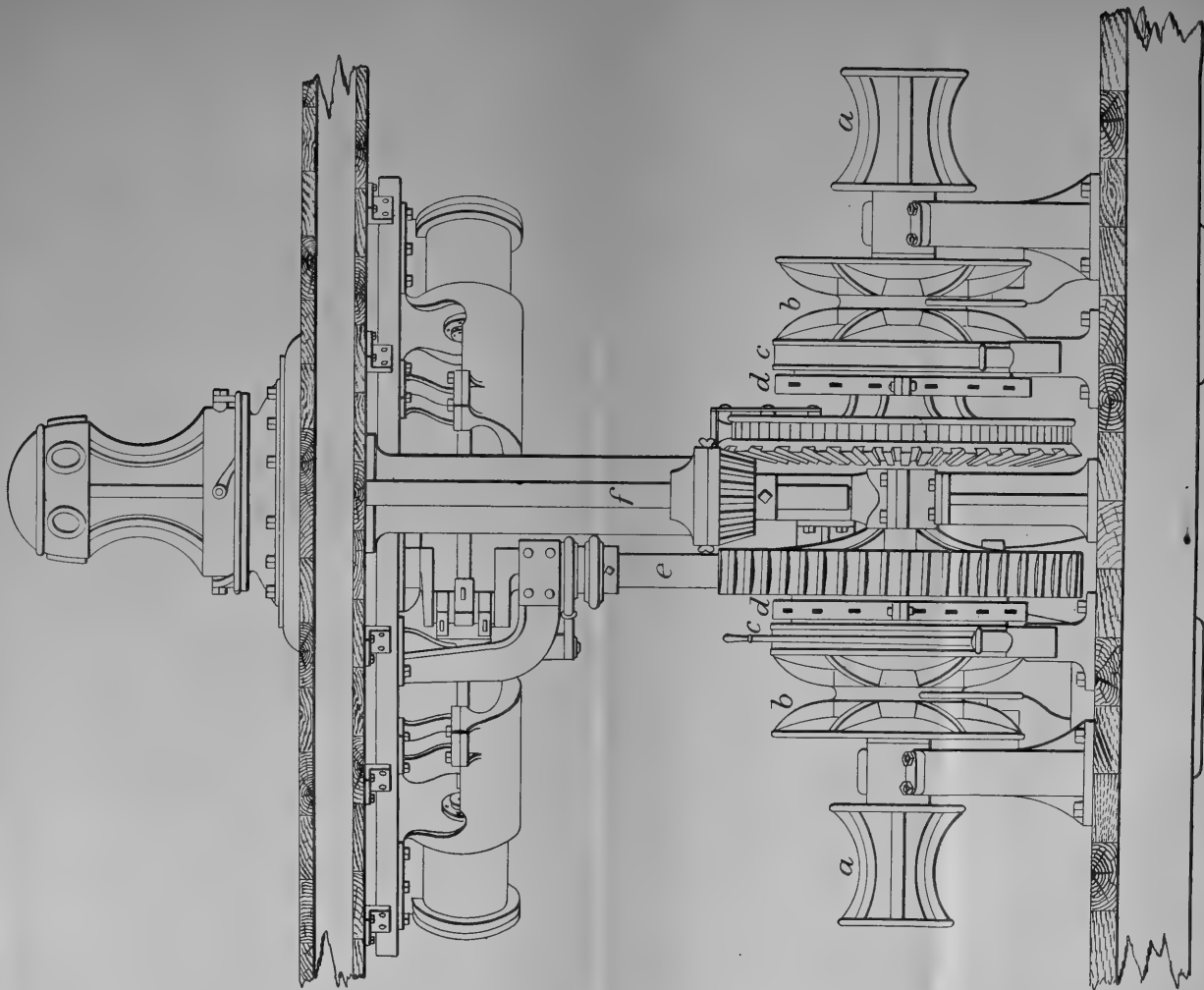


Fig. 2.

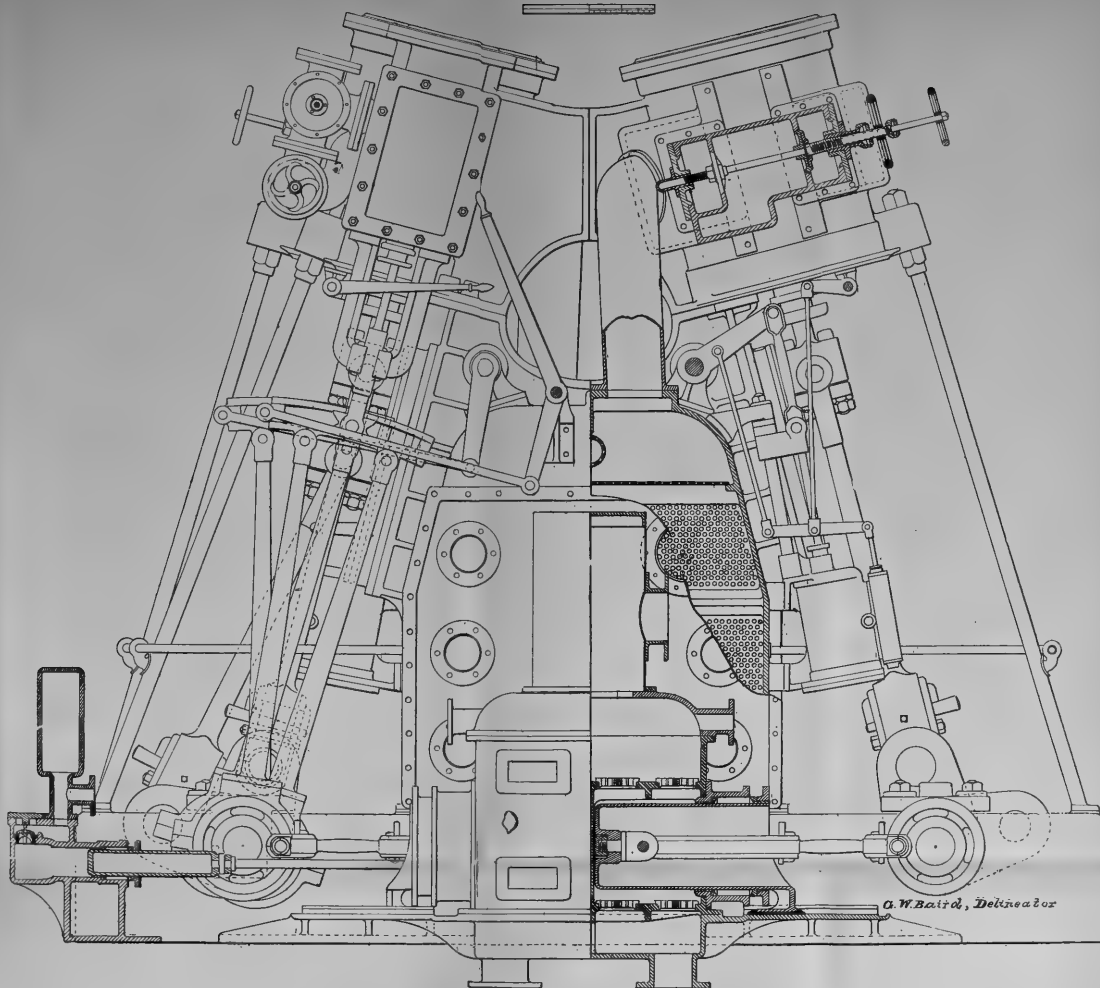




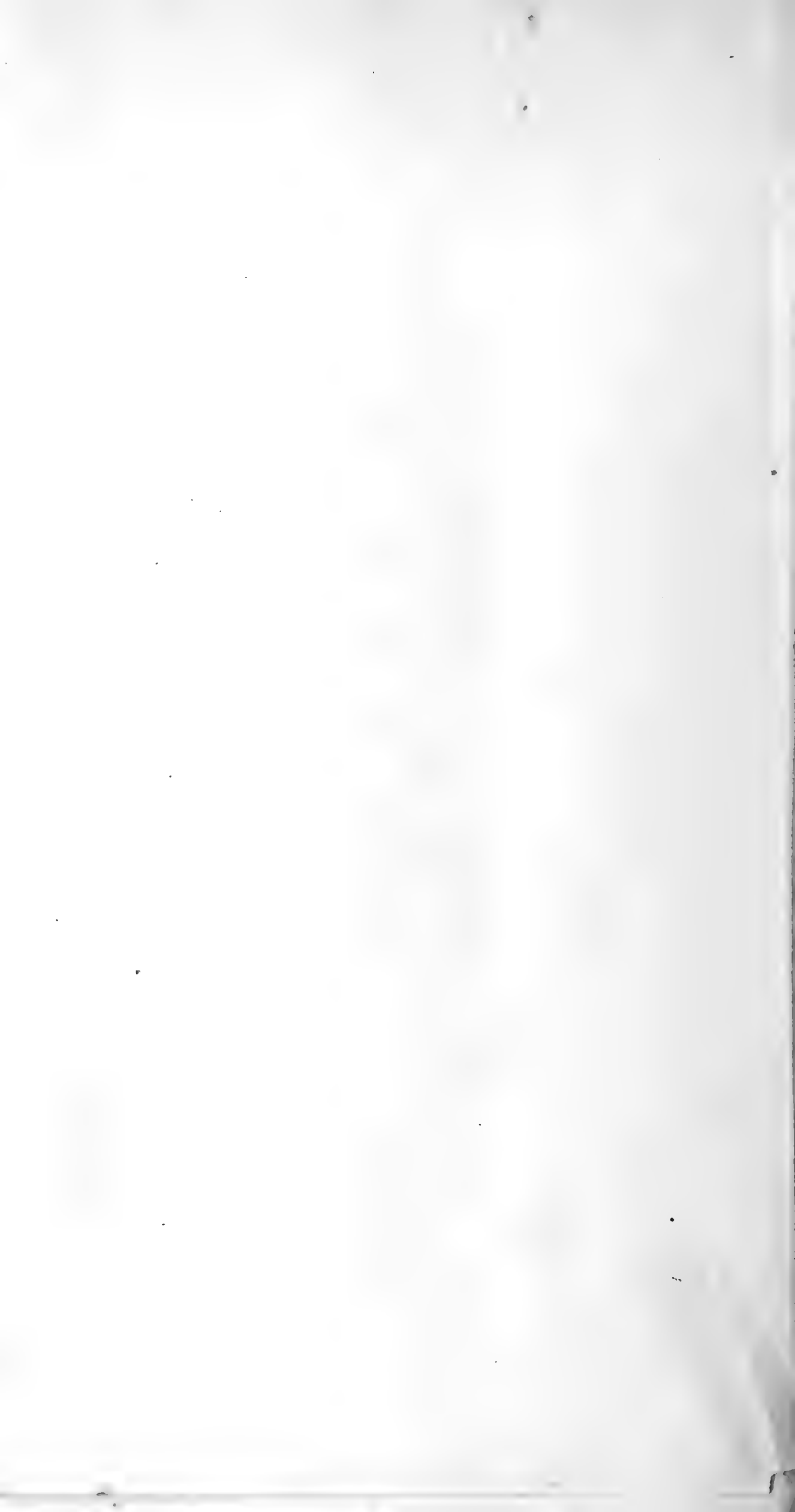


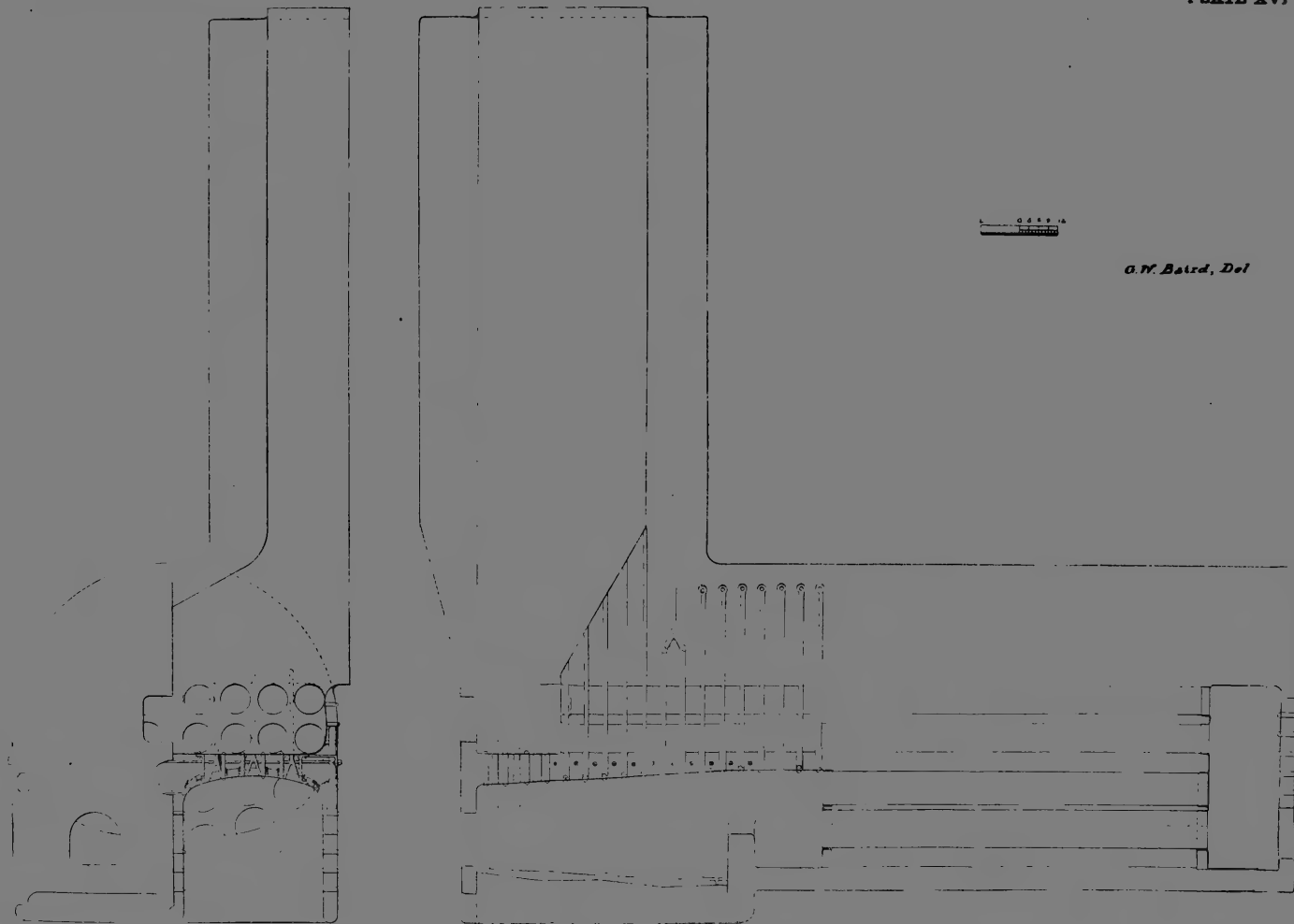
Steam windlass and capstan.





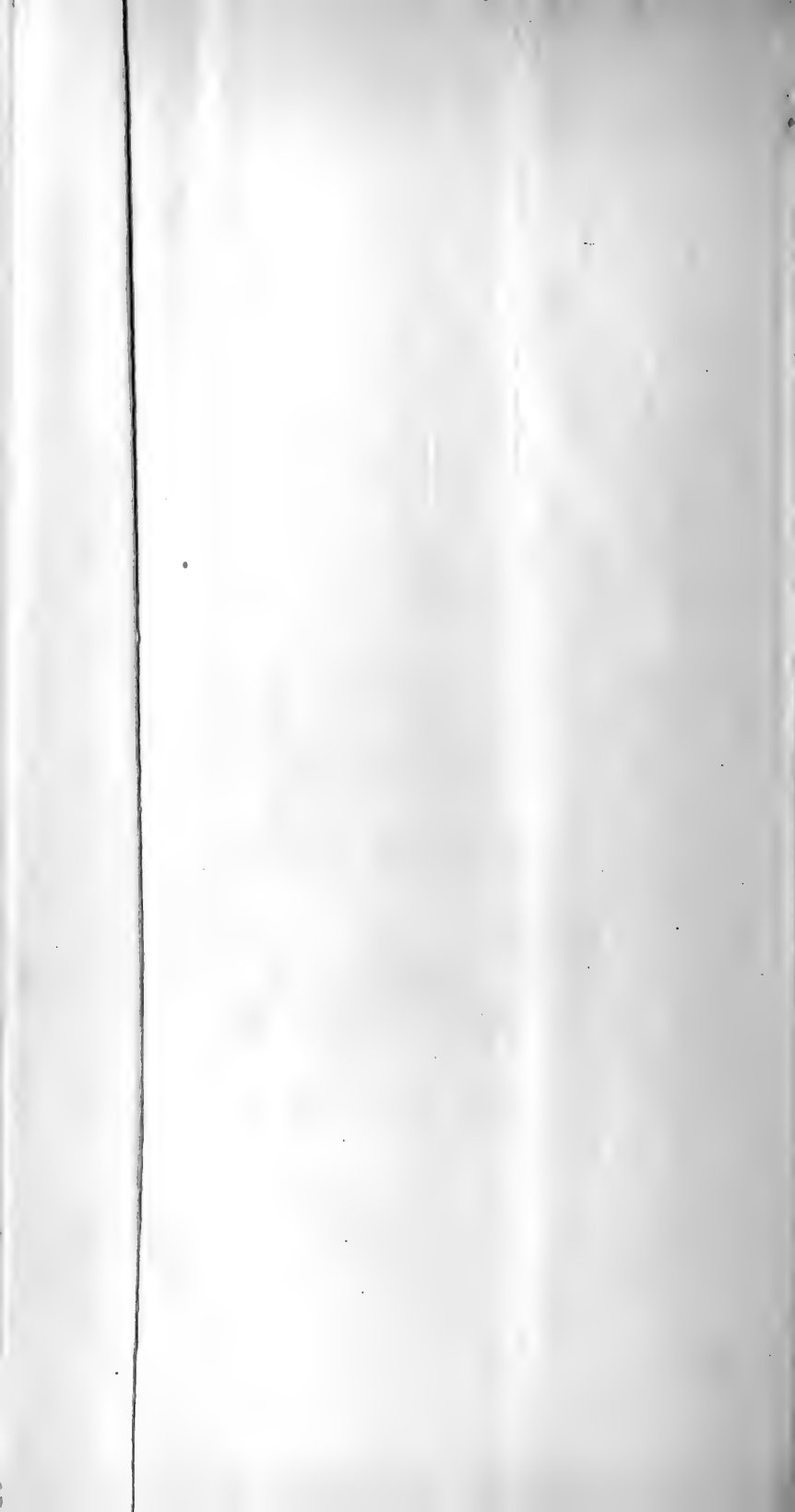
Compound twin-screw engines of the U. S. Fish Commission steamer Albatross.

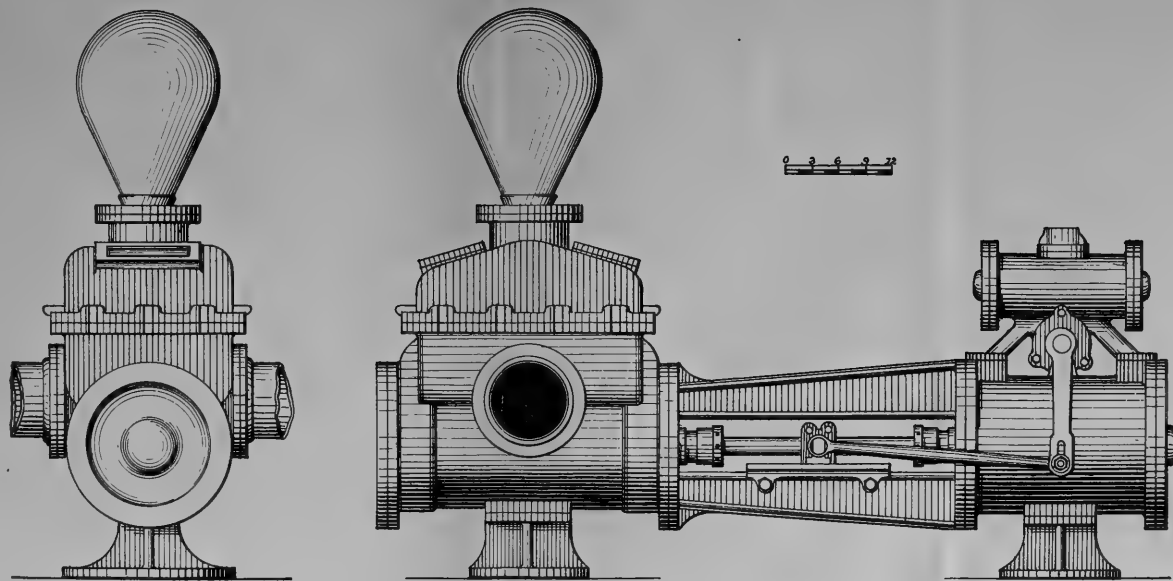




G. W. Baird, Del

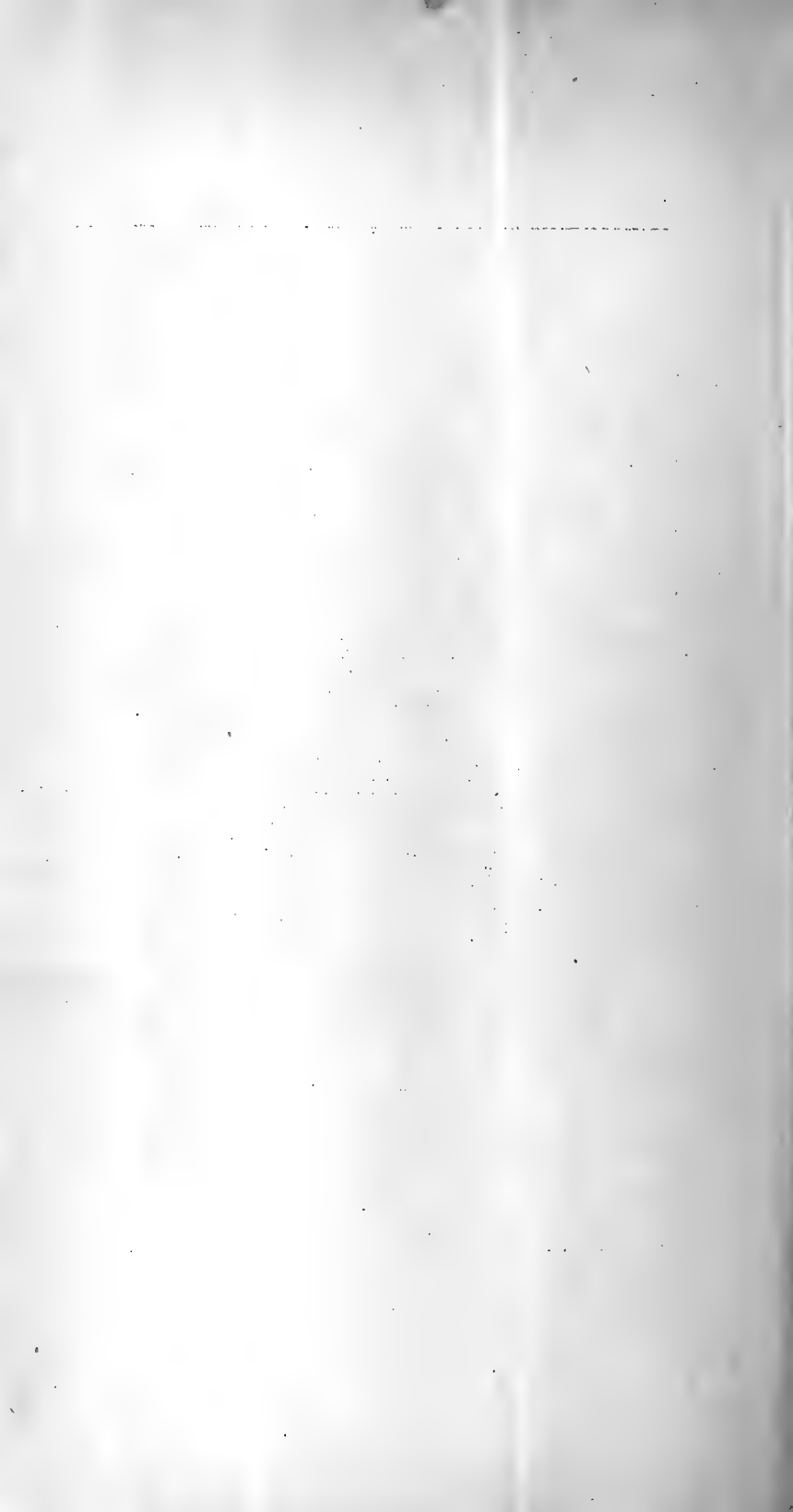
The return-flue boiler

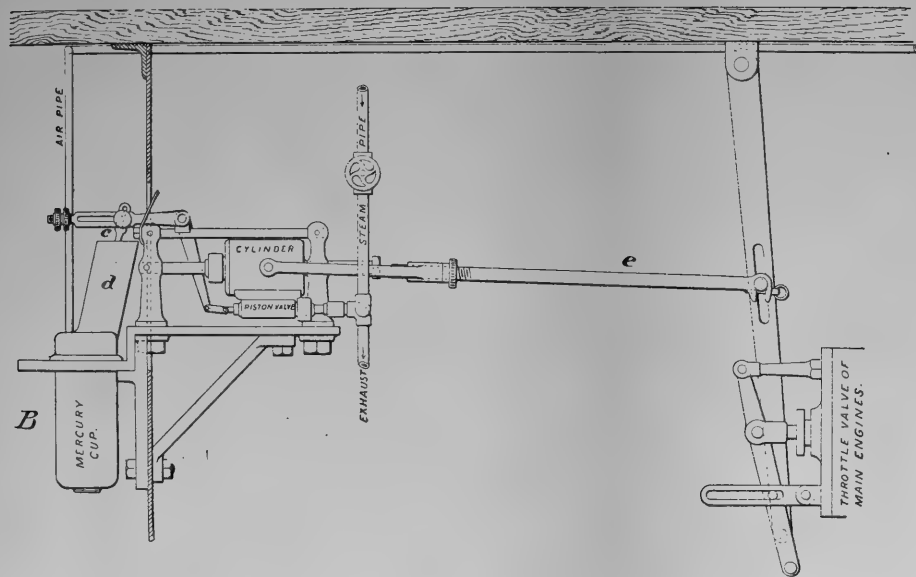




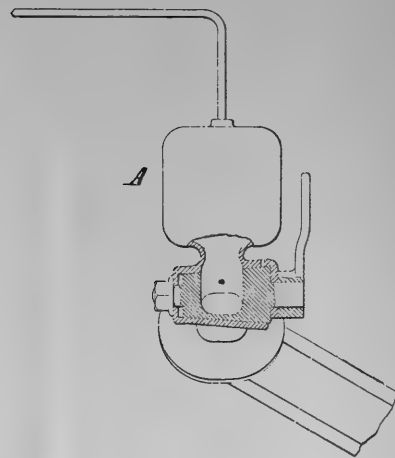
T.C. Breck.

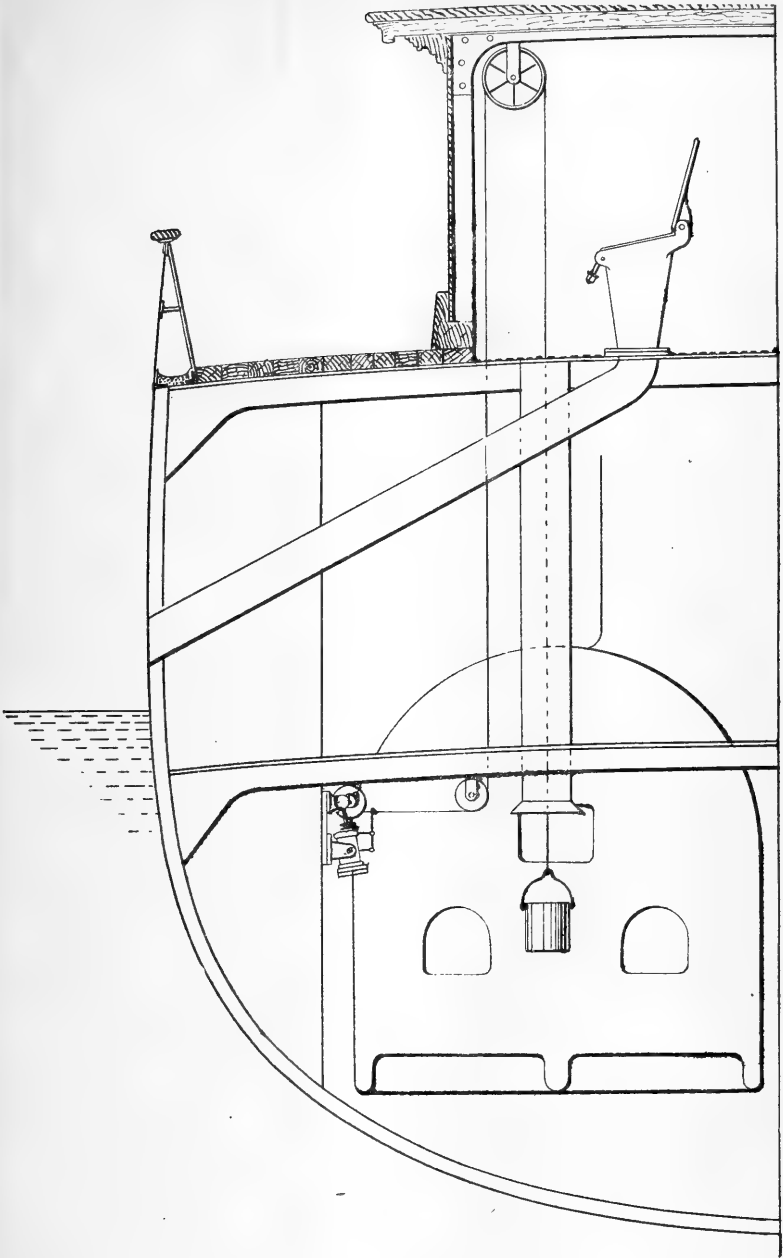
Circulating pump.





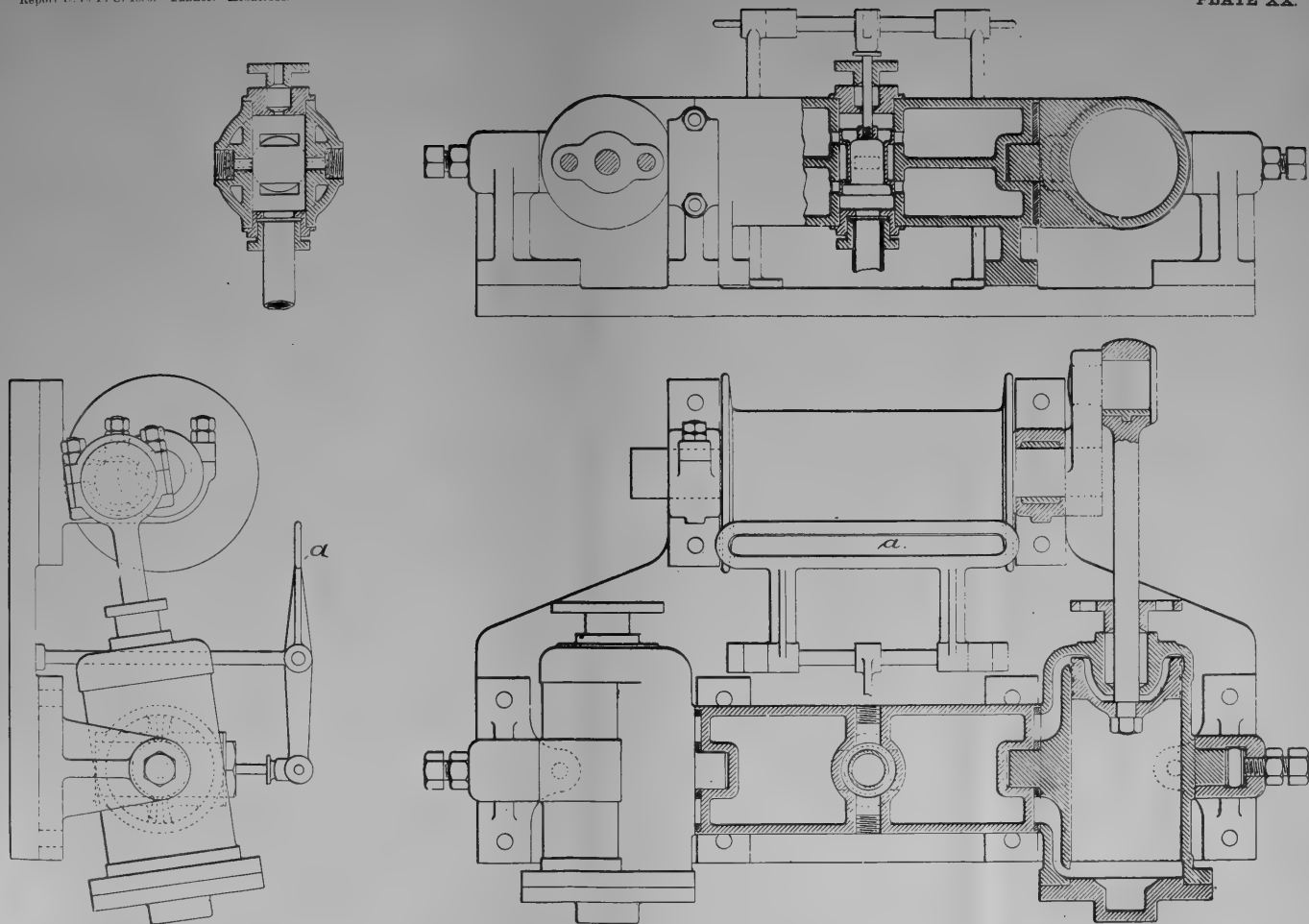
Svedberg's marine governor.





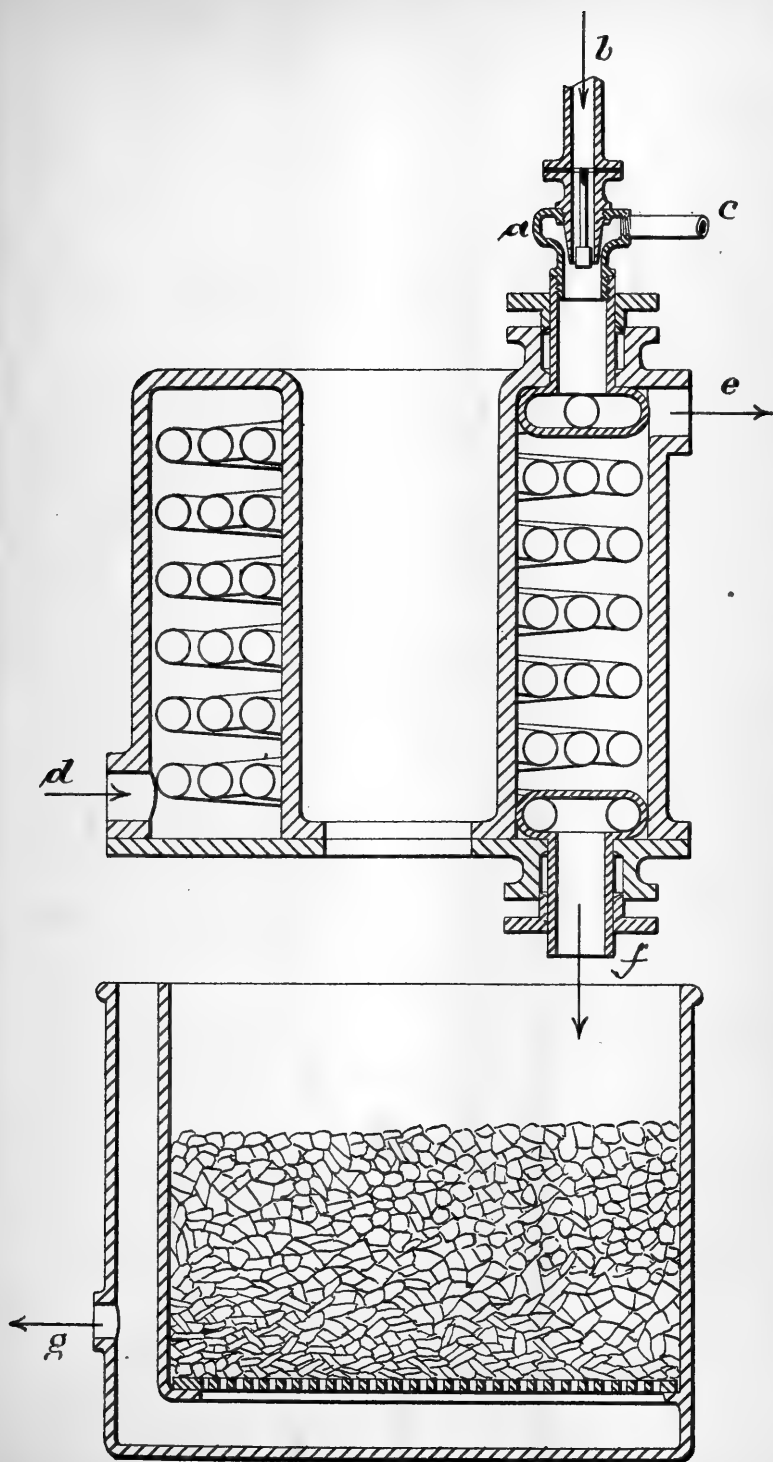
Ash elevator and shute.



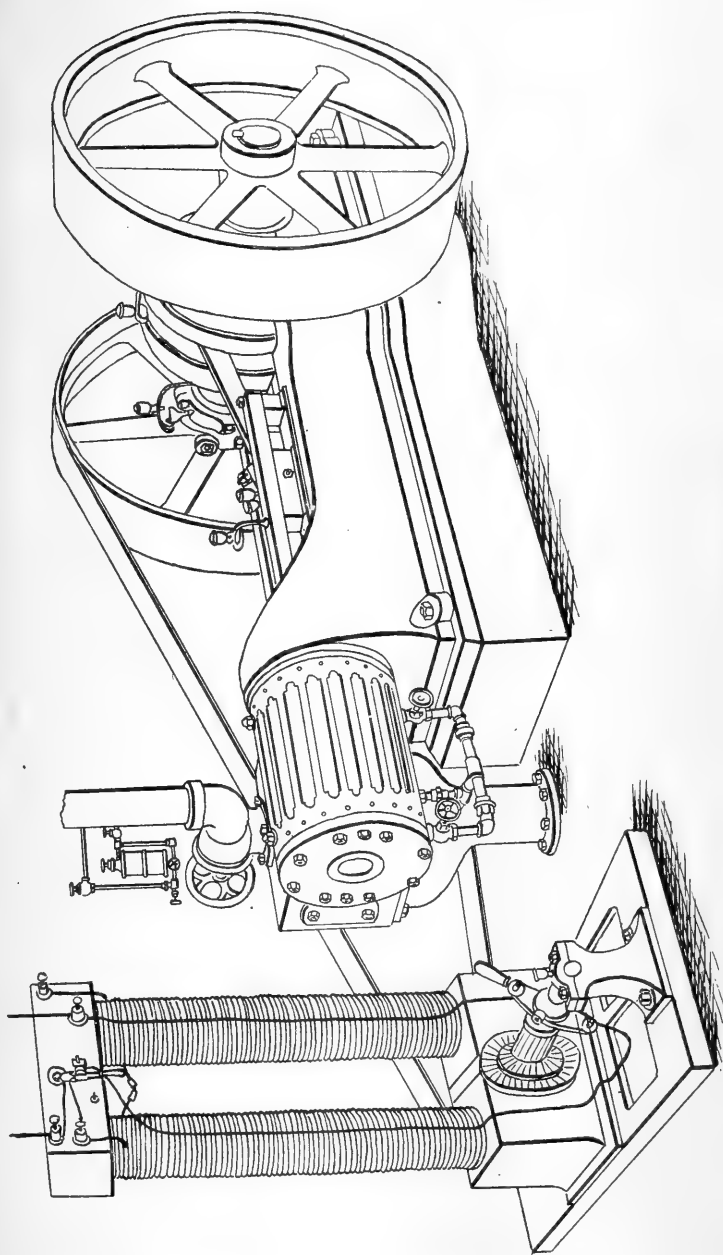


Ash-hoisting engine.

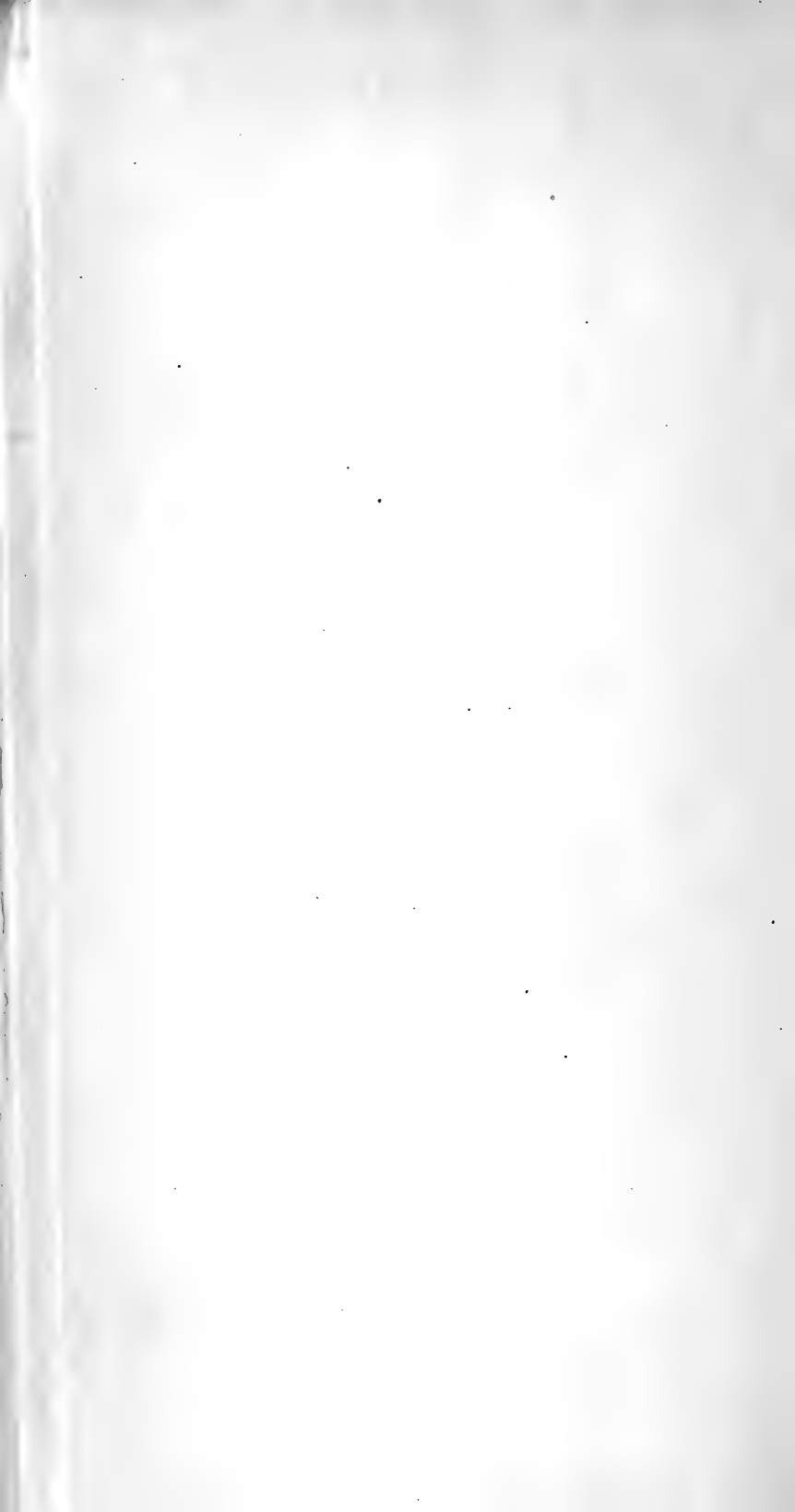


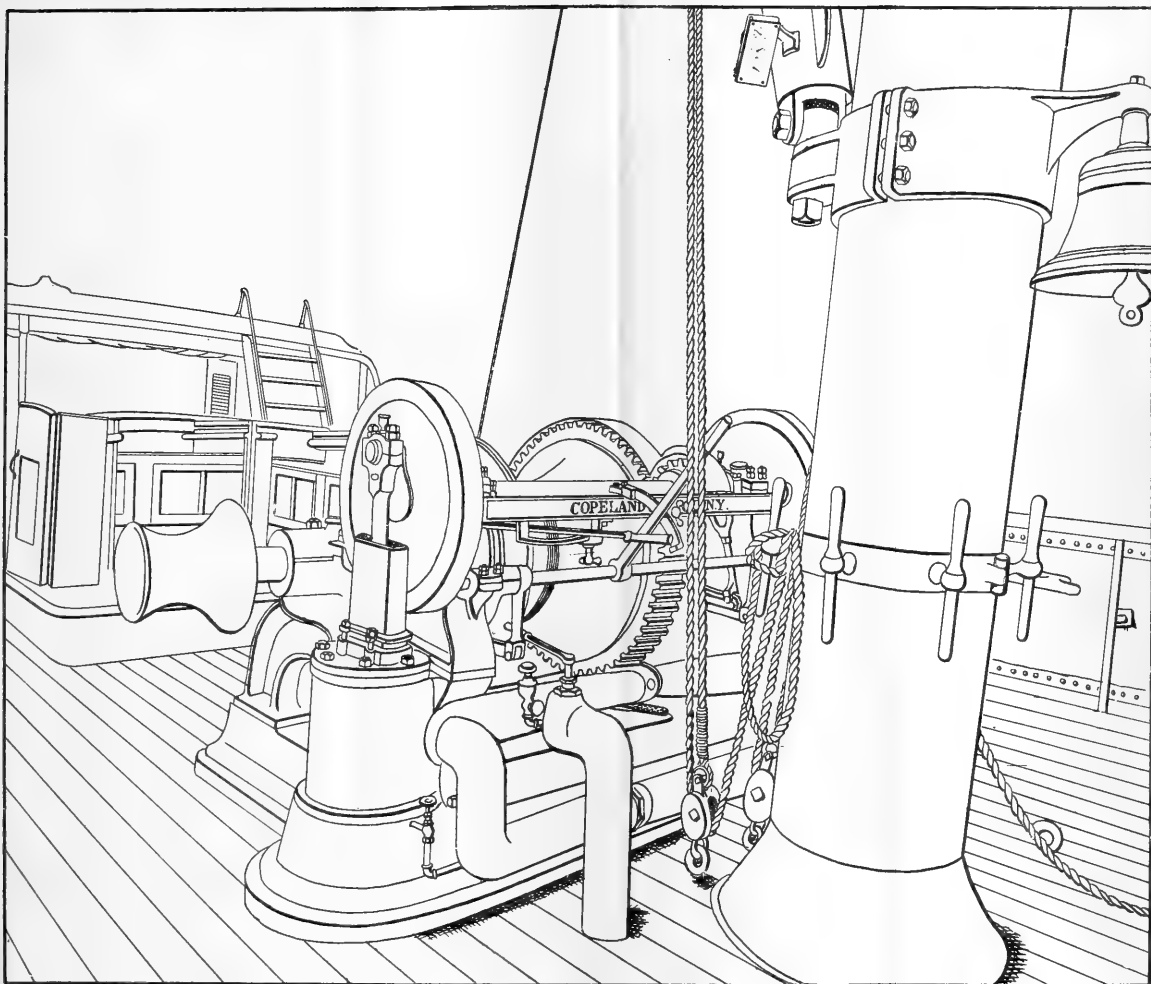


Fresh water distiller.

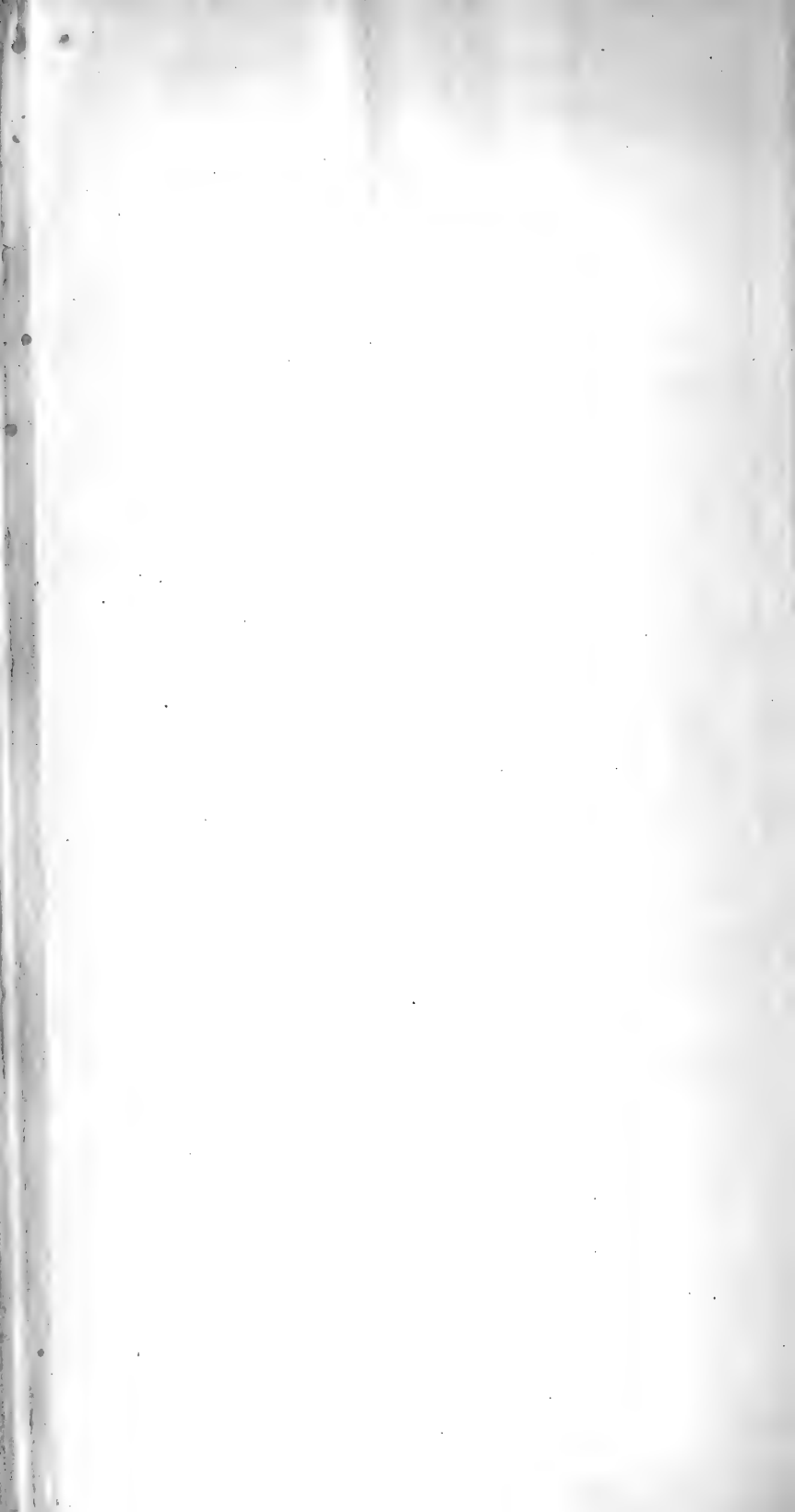


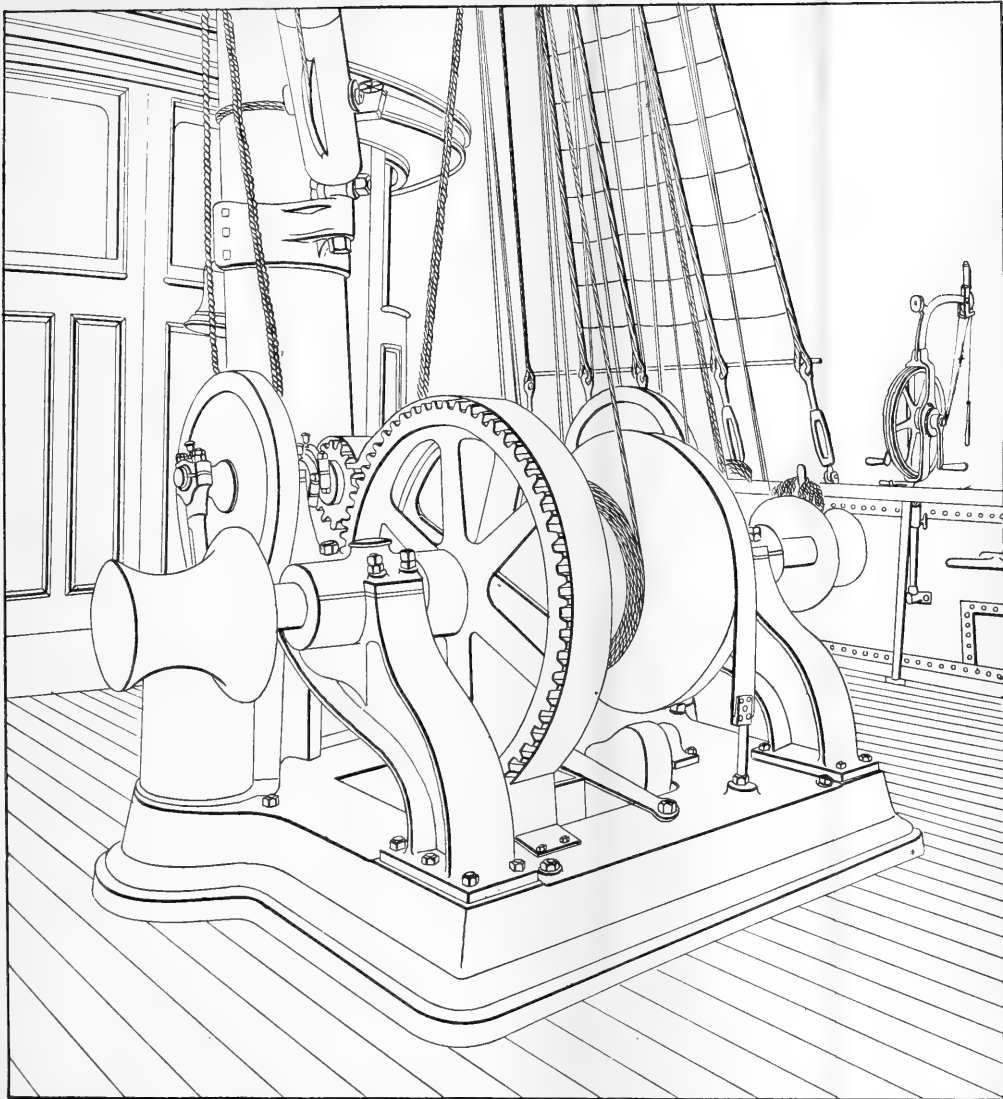
Edison dynamo and Arrington & Sims engine.



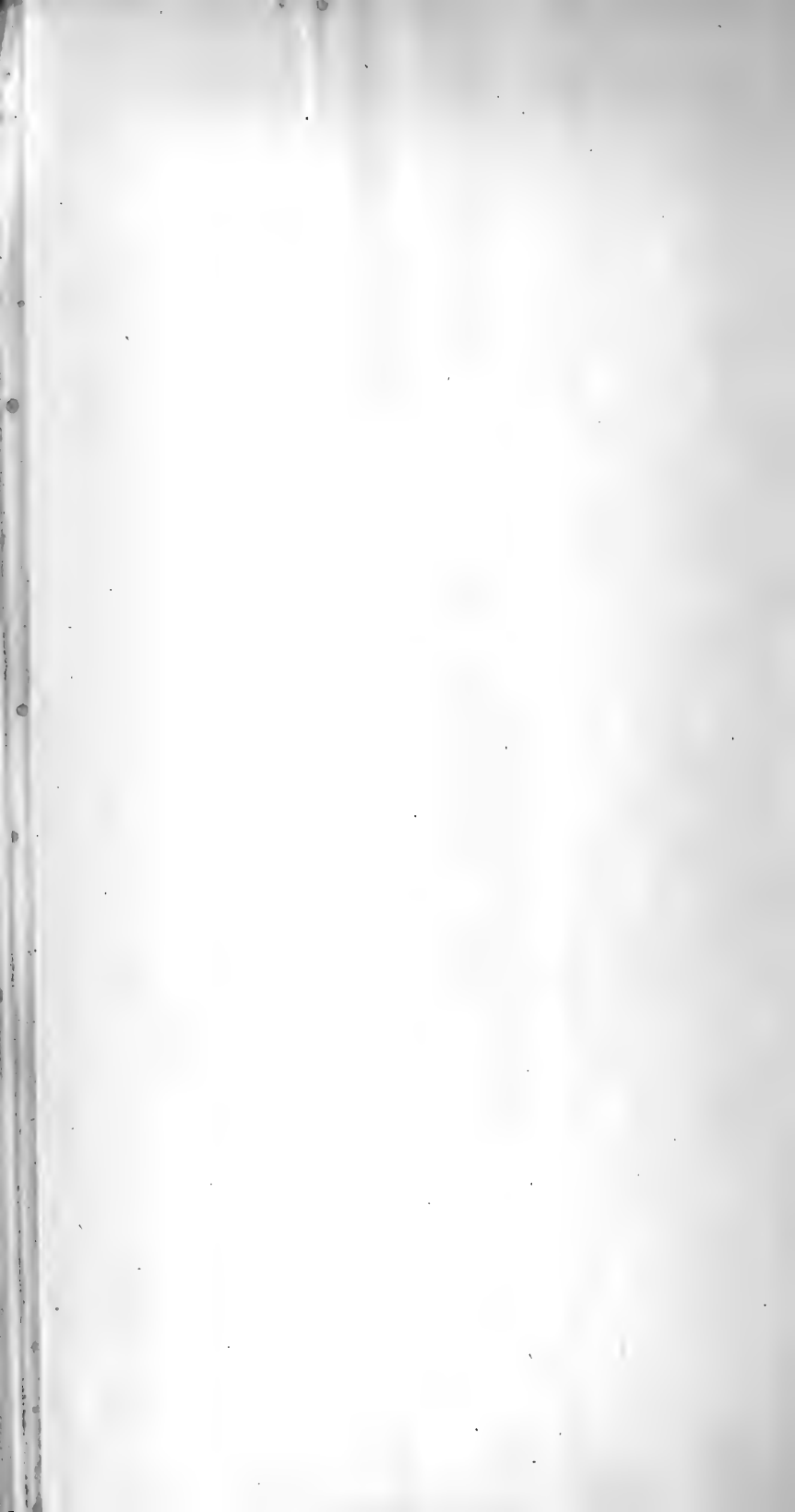


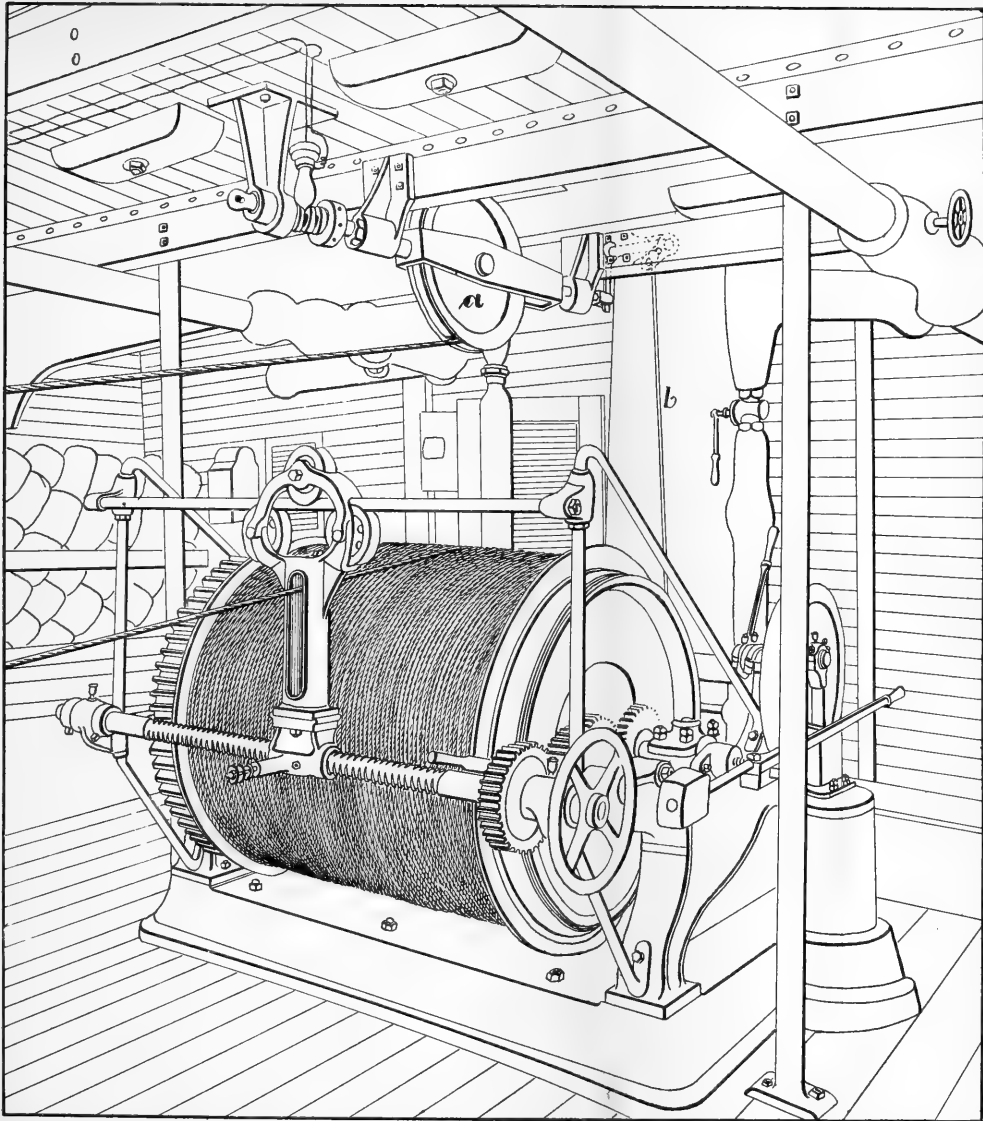
Dredging engine.





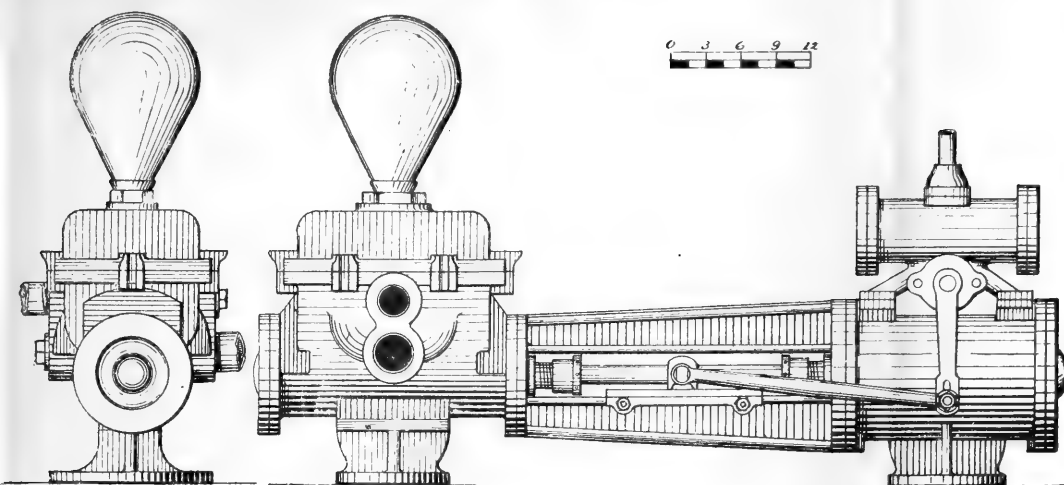
Dredging engine.



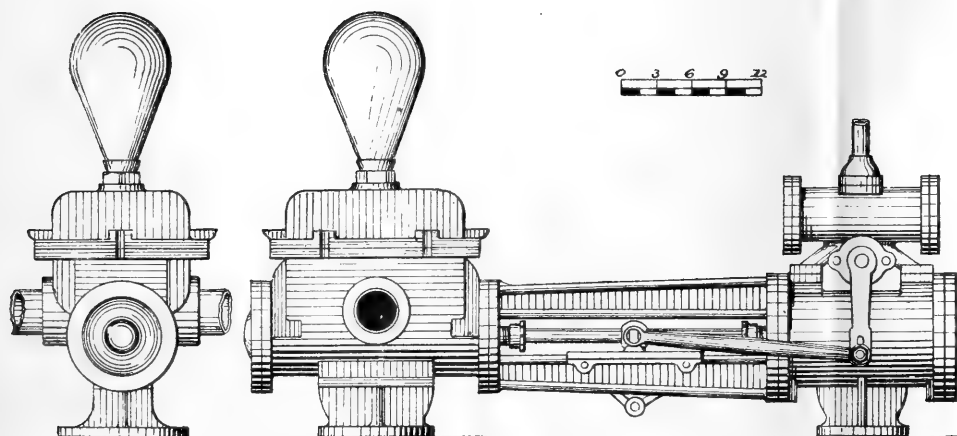


Reeling engine.

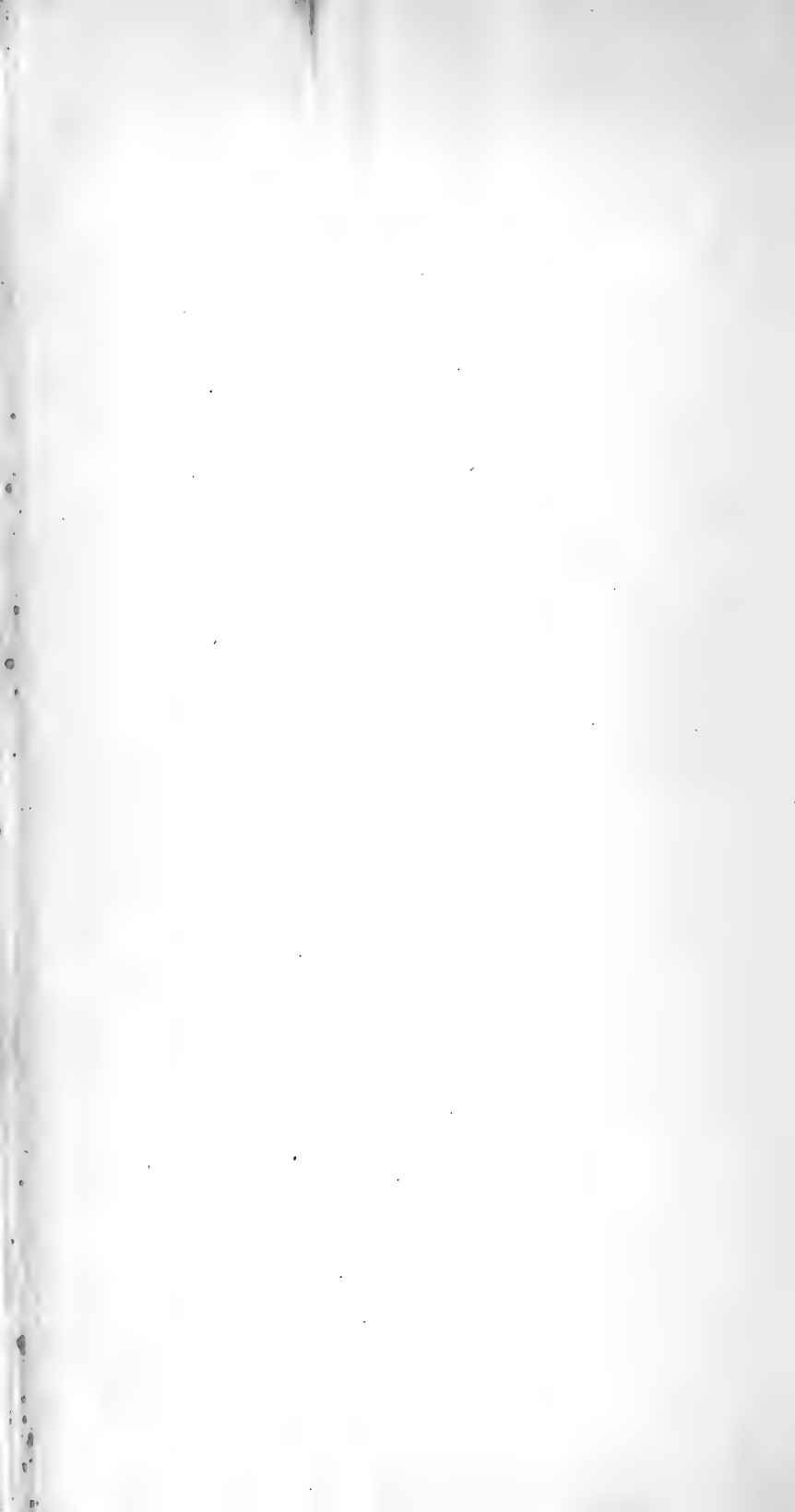


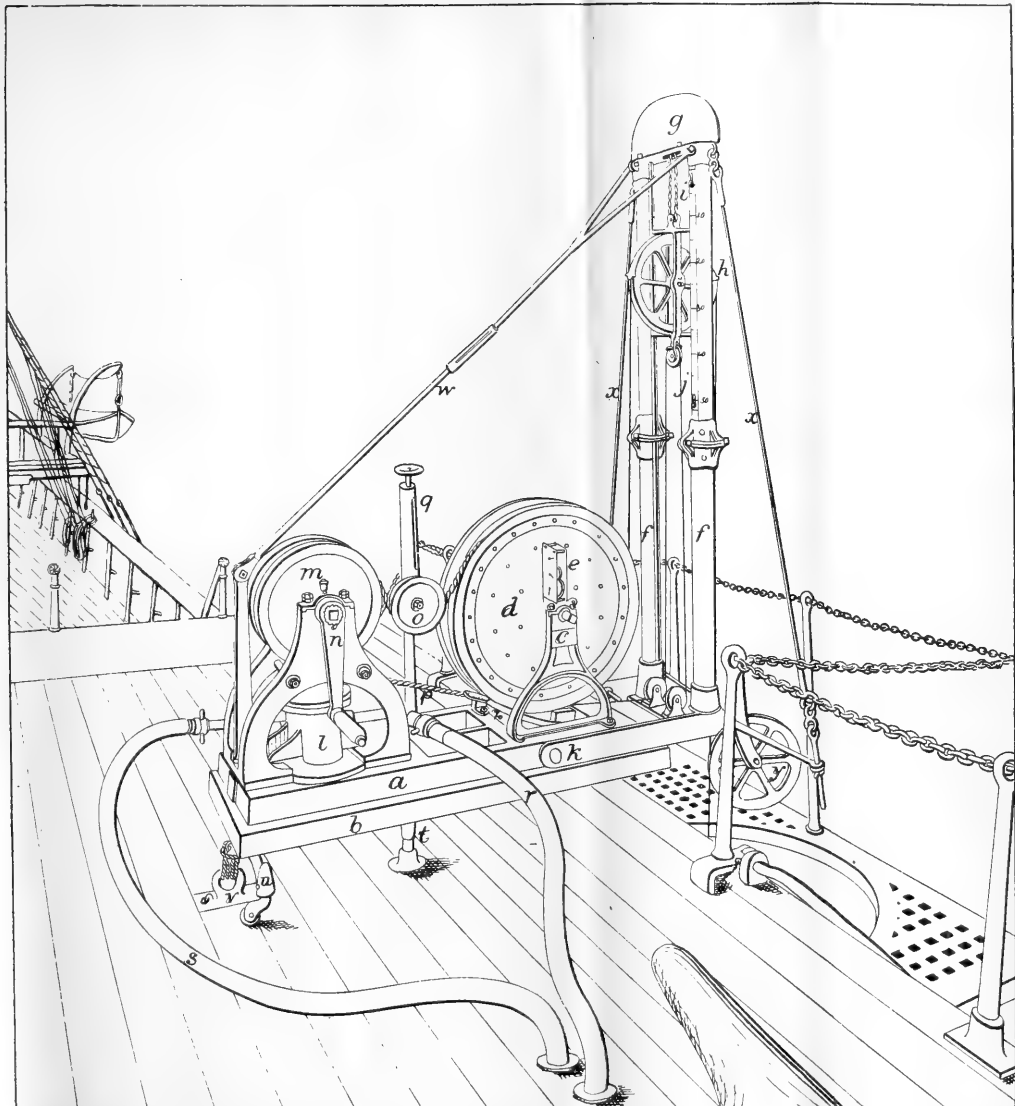


Boiler feed or fire pump.

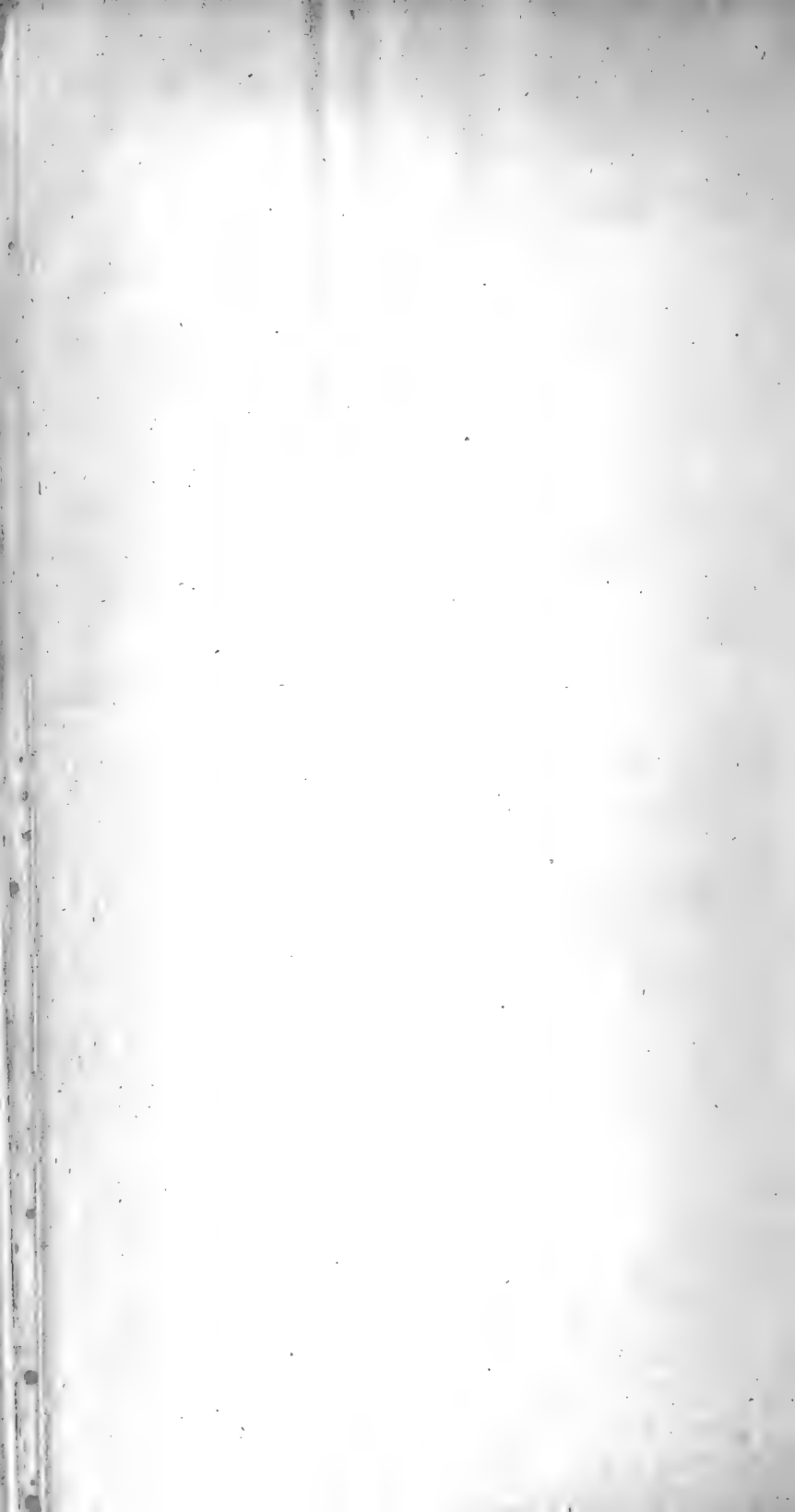


Hydrant pump.





Sigbee's machine for sounding with wire, rigged for reeling in.



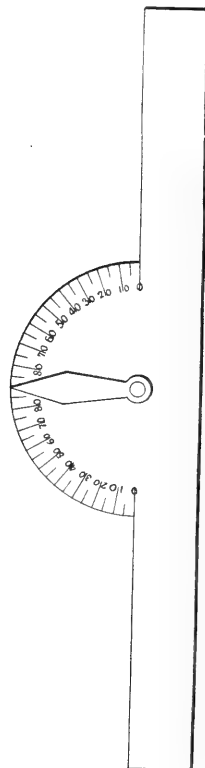
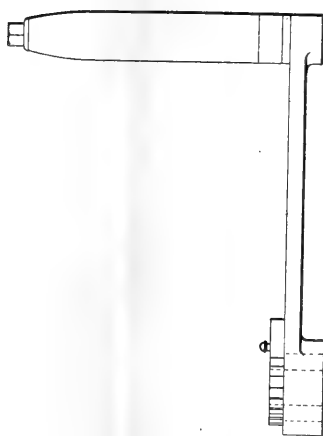
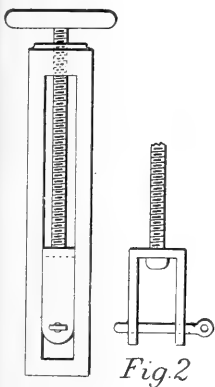
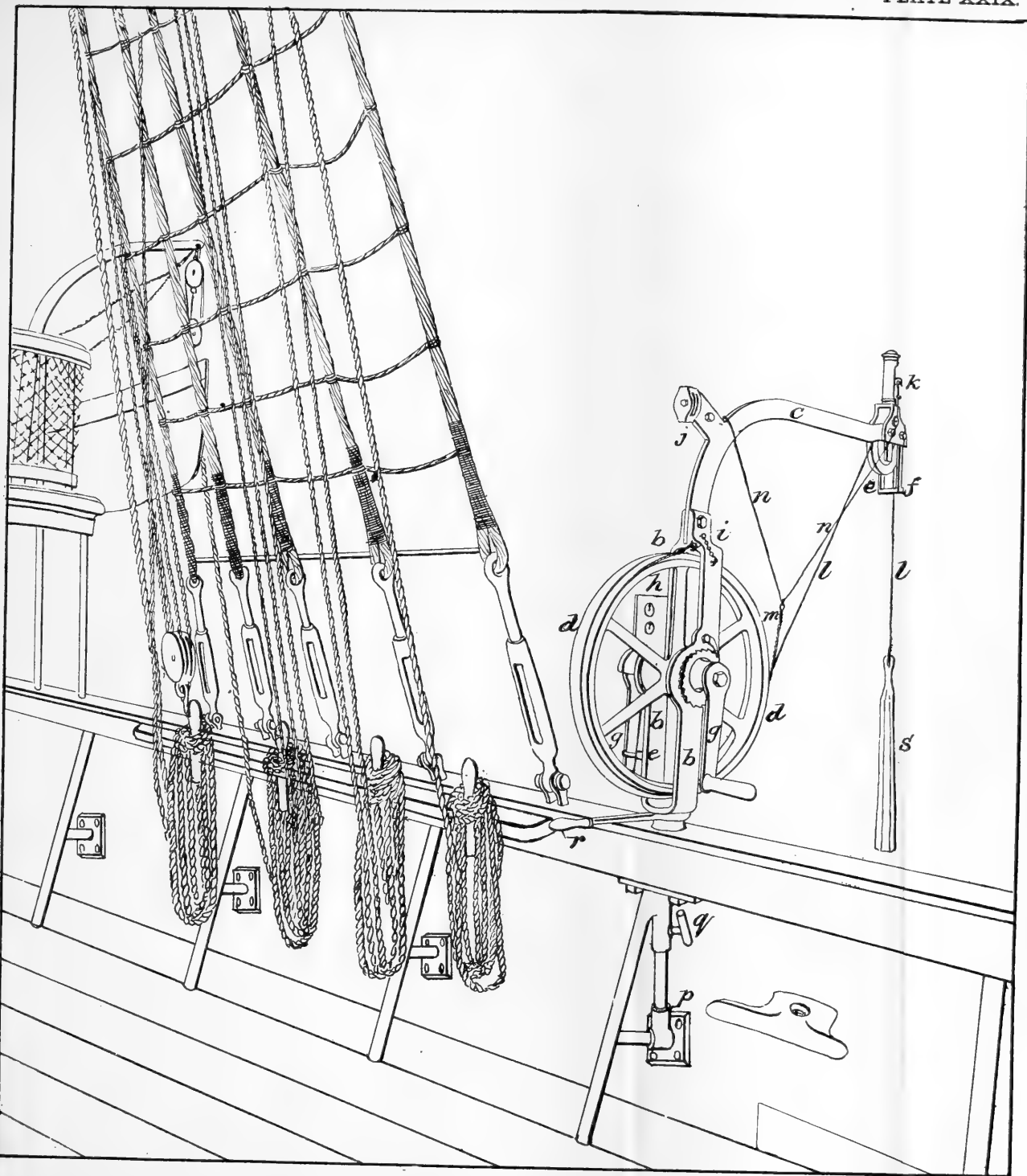


Fig. 1

Fig. 2.

Belt-tightener, ratchet-crank, and dredging quadrant.



Tanner sounding machine.

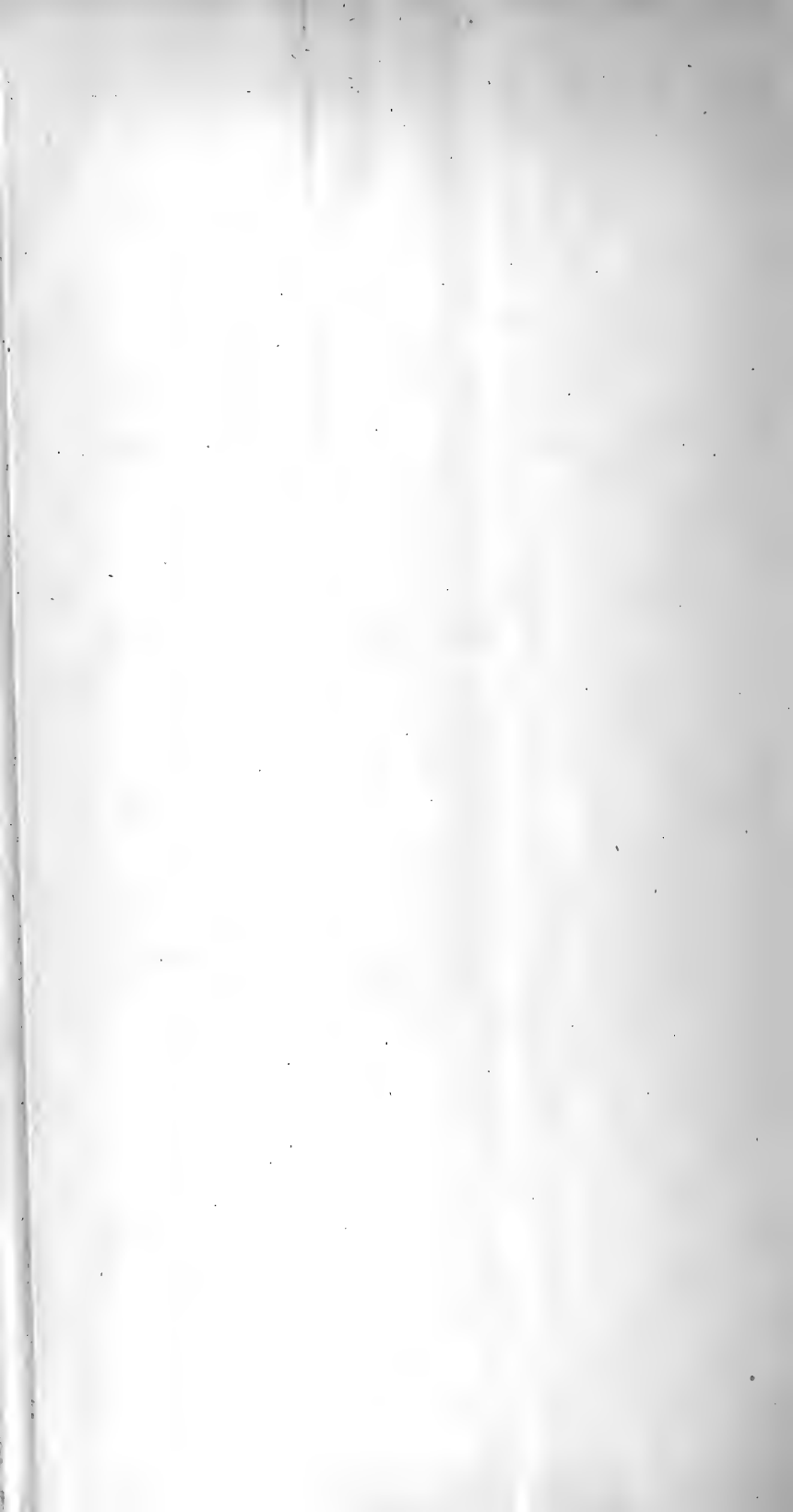




Fig. 1.

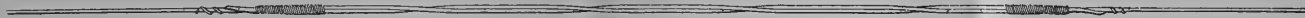


Fig. 2.

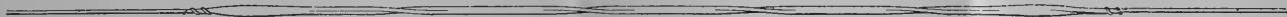


Fig. 3.

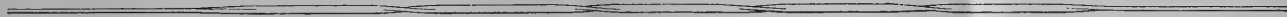
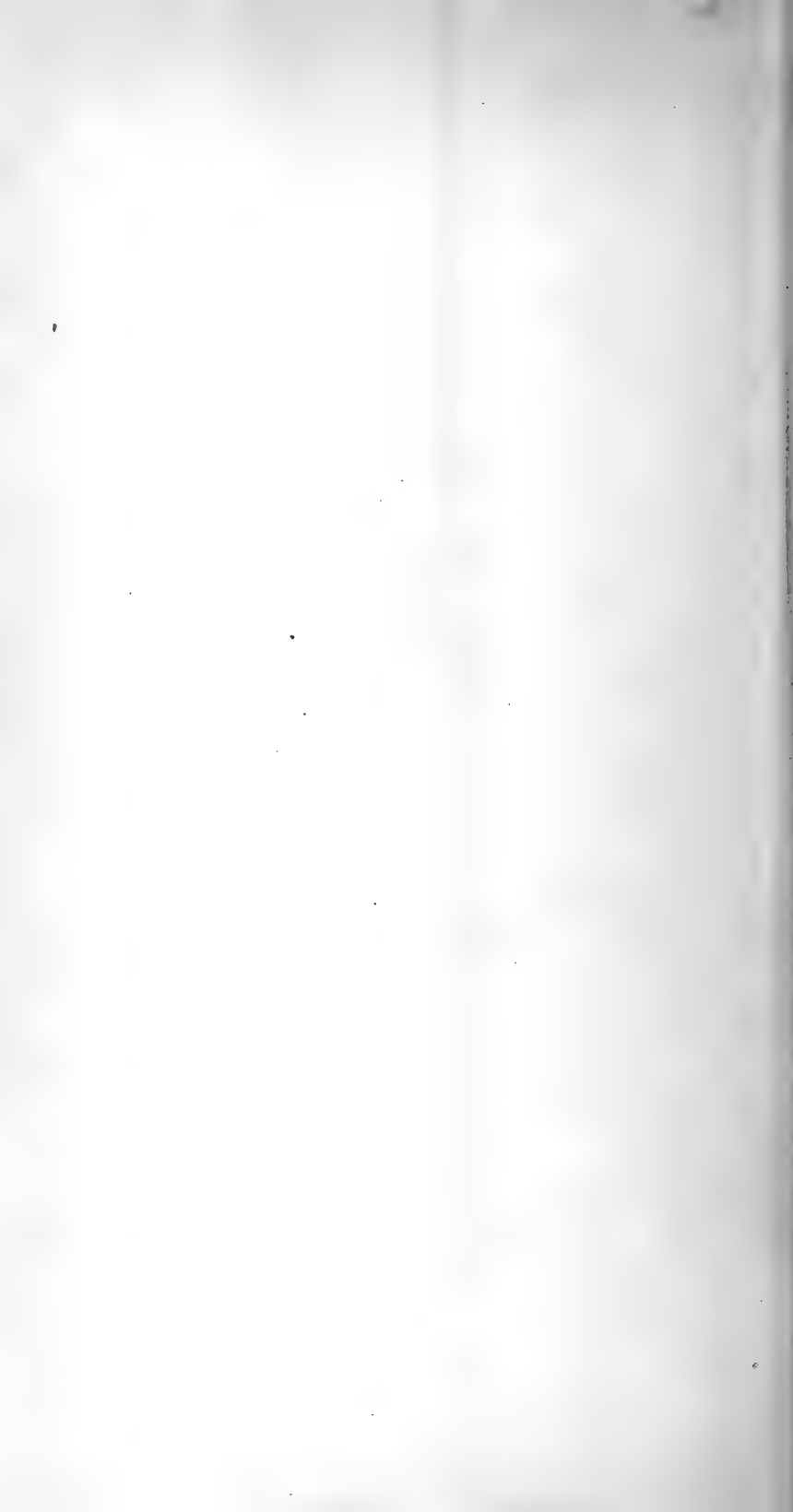


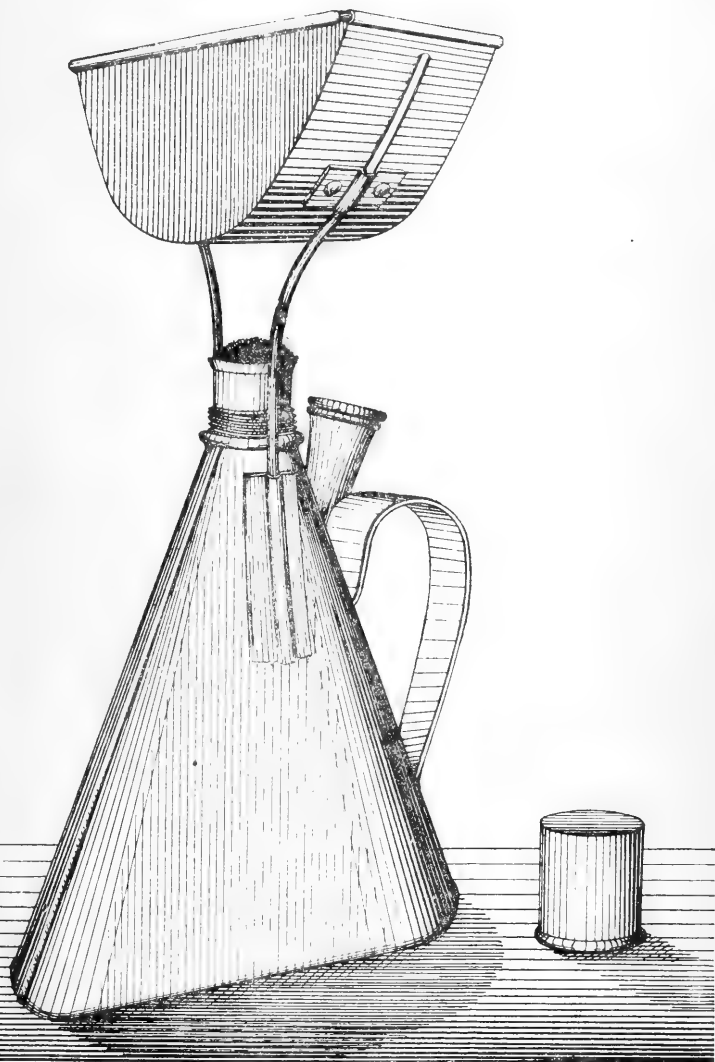
Fig. 4.



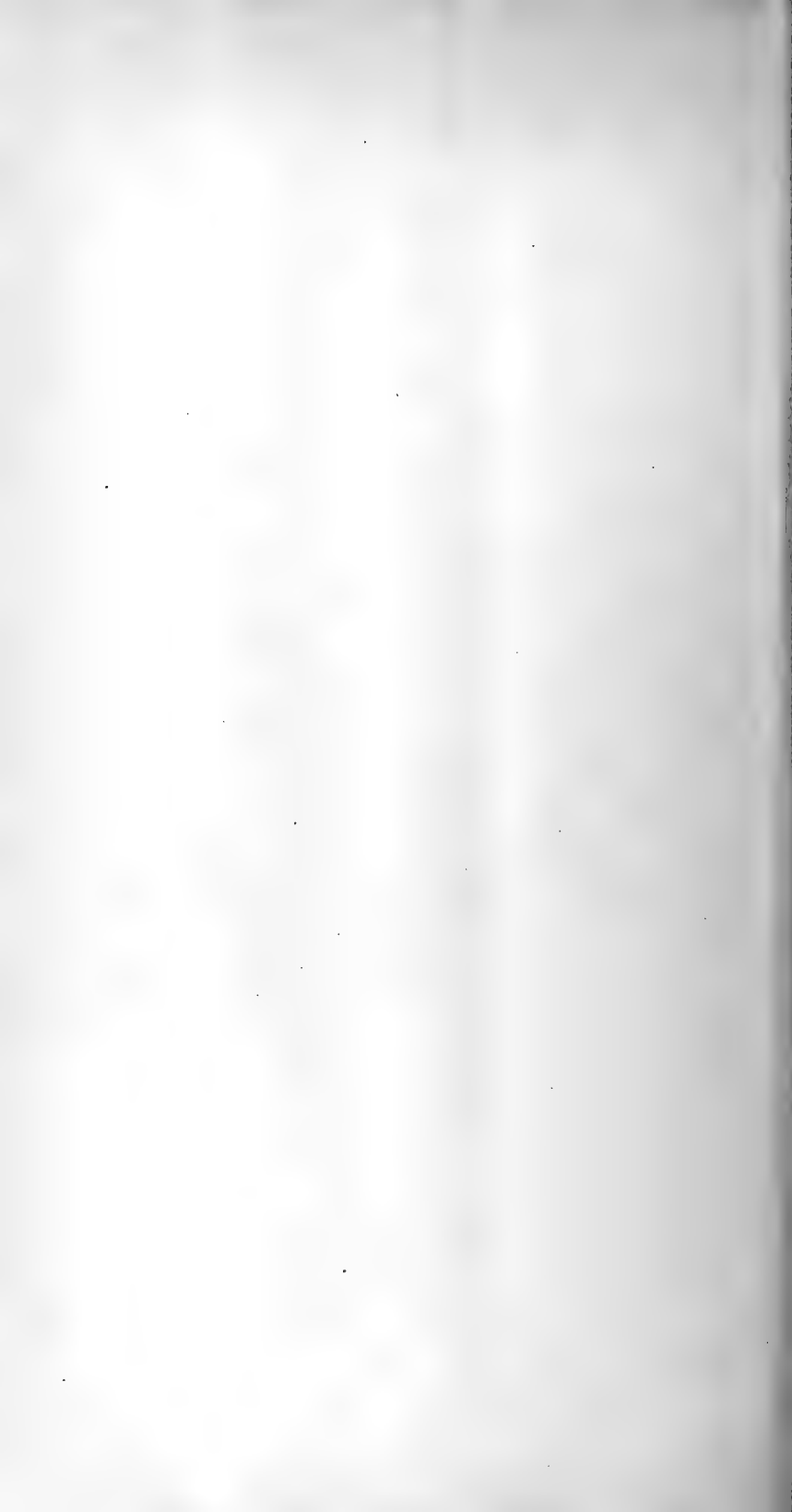
Fig. 5.

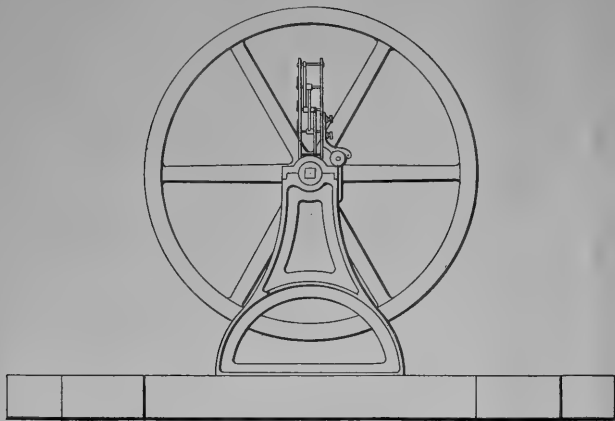
Wire splices.





Soldering lamp.





Measuring reel.

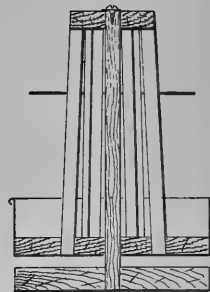


Fig. 1.

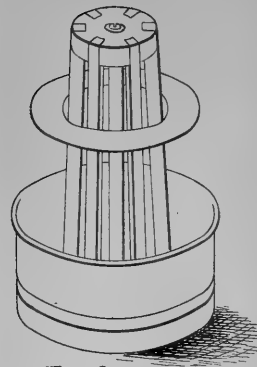


Fig. 2.

Blade.

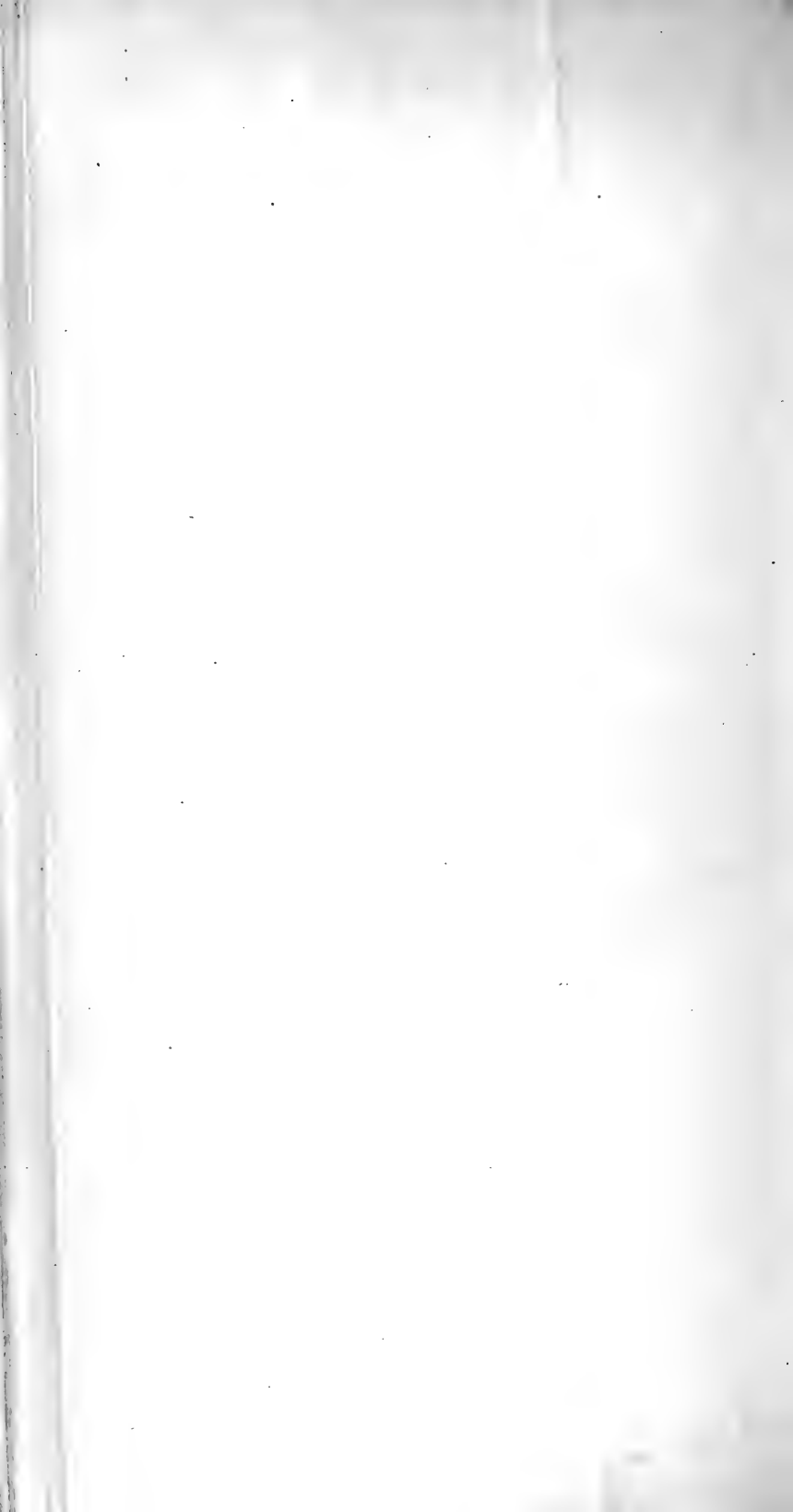




Fig. 5.

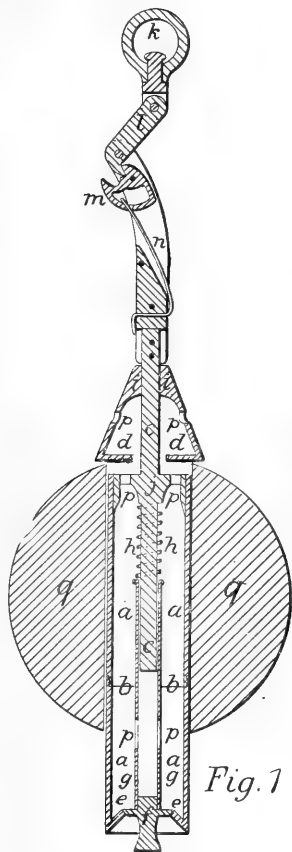


Fig. 1

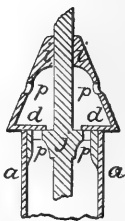


Fig. 6.

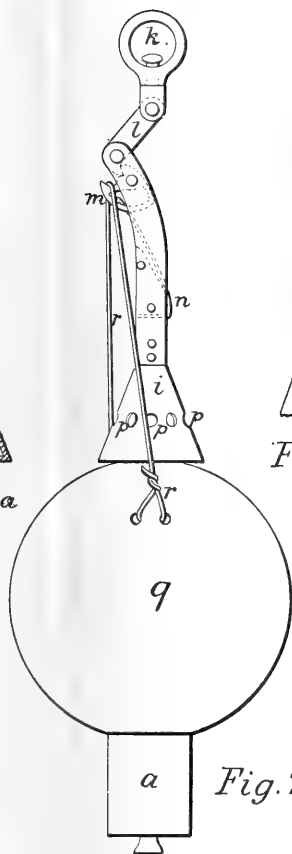


Fig. 2.



Fig. 4.

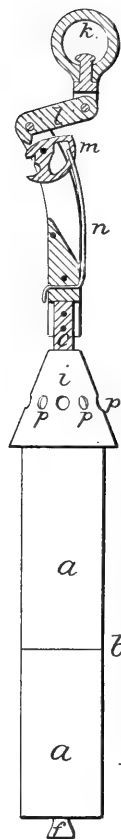


Fig. 3.



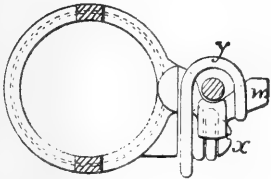
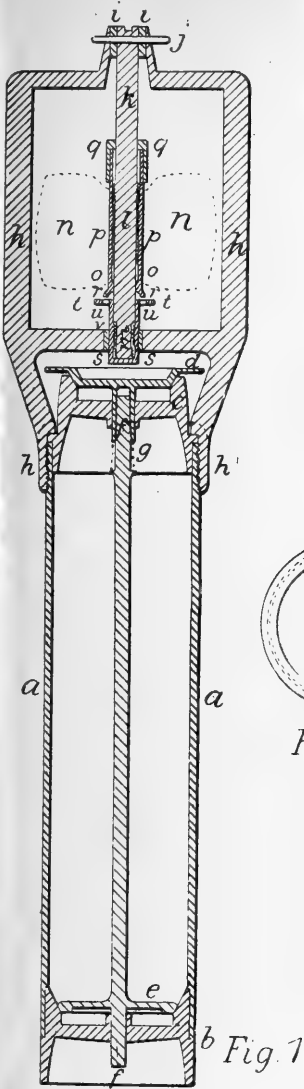


Fig. 4

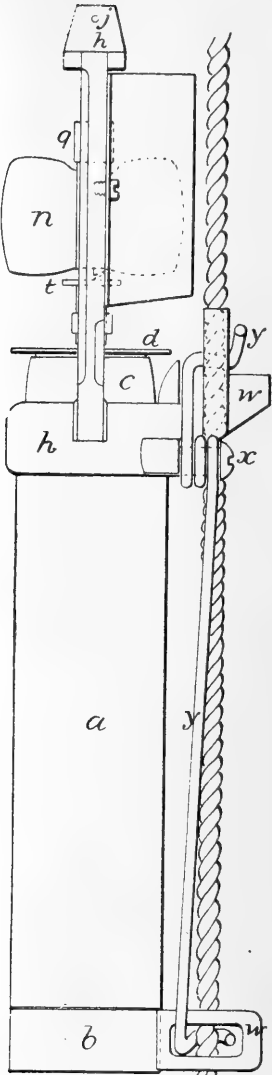


Fig. 2.



Fig. 5

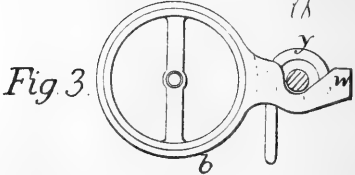
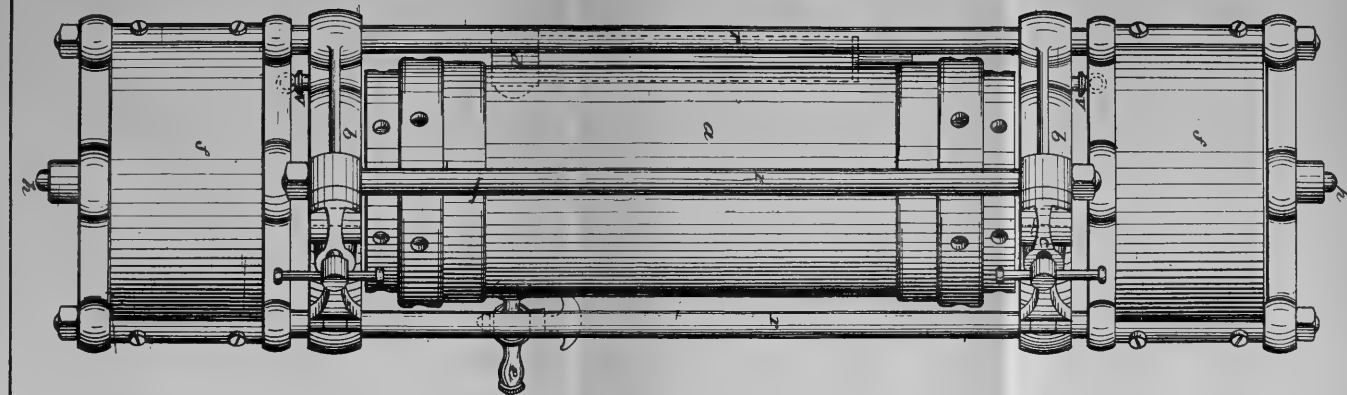


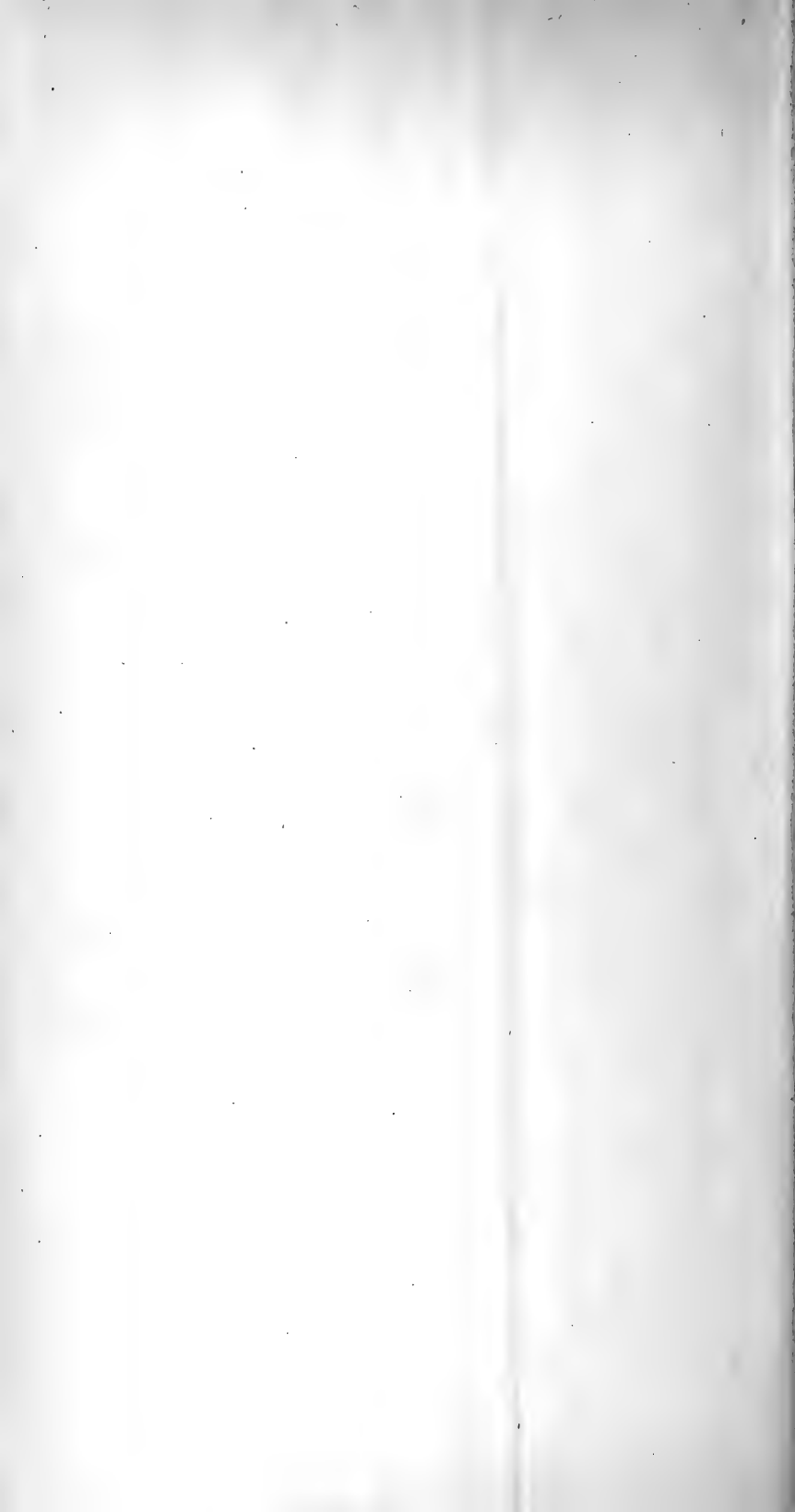
Fig. 3.

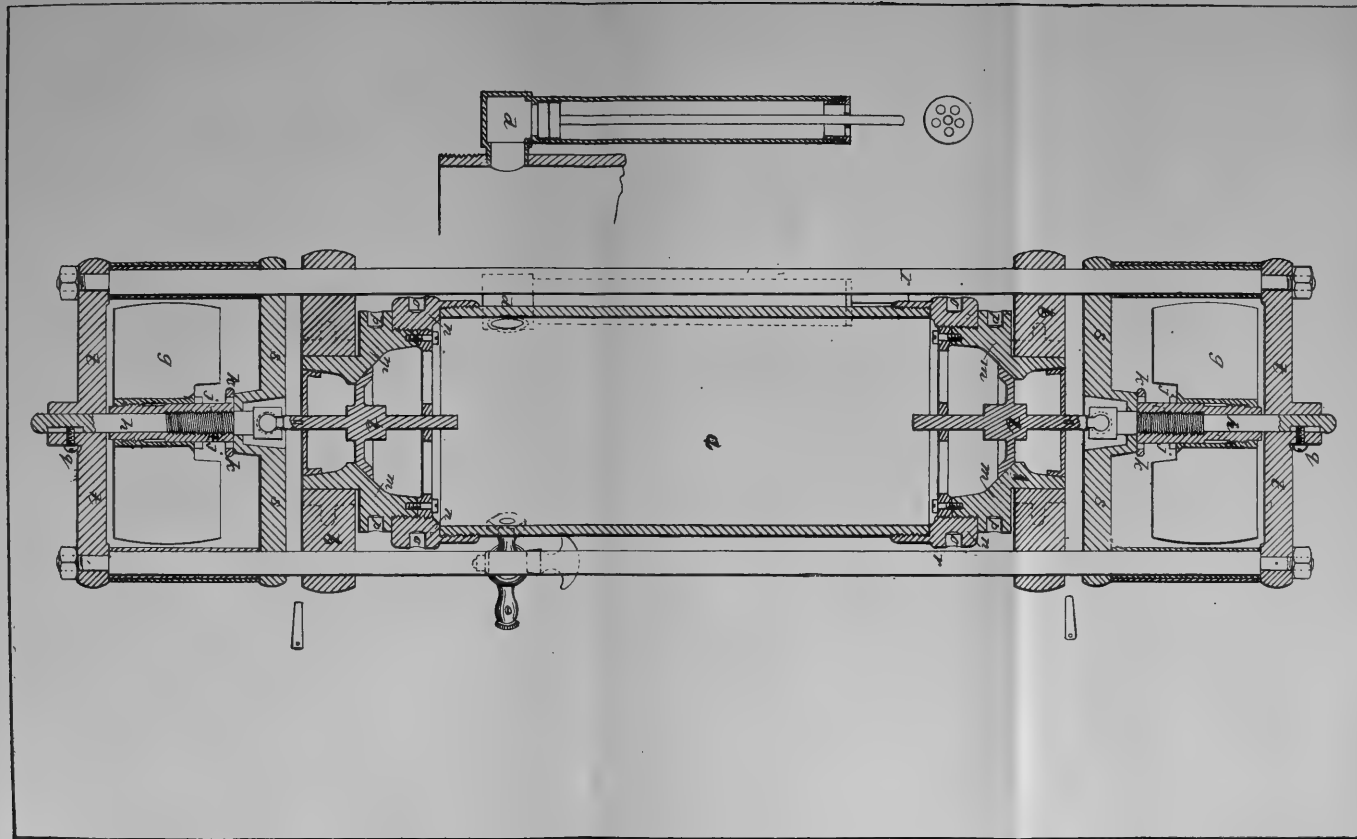
Sigsbee's water-specimen cup.





Improved water-bottle.





Improved water-bottle, sectional elevation.



Fig. 1.



Fig. 2.

Figs. 1 and 2. Side and bottom view of arm of propeller frame.



Fig. 3.



Fig. 4.

Figs. 3 and 4. Side and bottom view of arms of propeller frame.



Fig. 5.

Fig. 5. Side view of frame b showing clamp c.

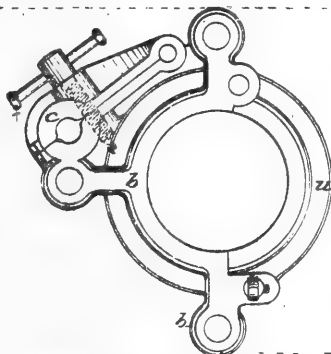


Fig. 6.

Fig. 6. Front view of frame b, clamp c, and clamp u.



Fig. 7.

Fig. 7. Side view of frame b, clamp u, and pin v.



Fig. 8.

Fig. 8. Side view of the sleeve i and front view of beveled slots k k.

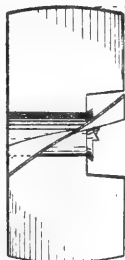


Fig. 9.

Fig. 9. Side view of propeller showing beveled lugs.

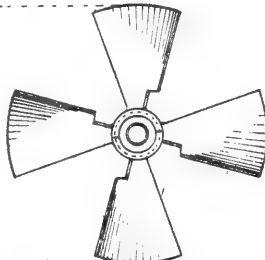


Fig. 10.

Fig. 10. Bottom view of propeller.

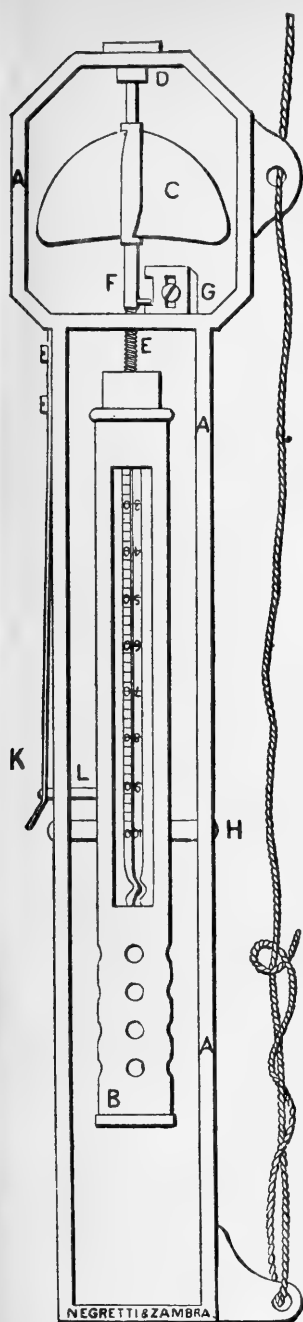


Fig. 1.

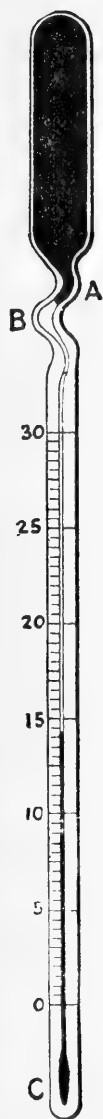


Fig. 3.

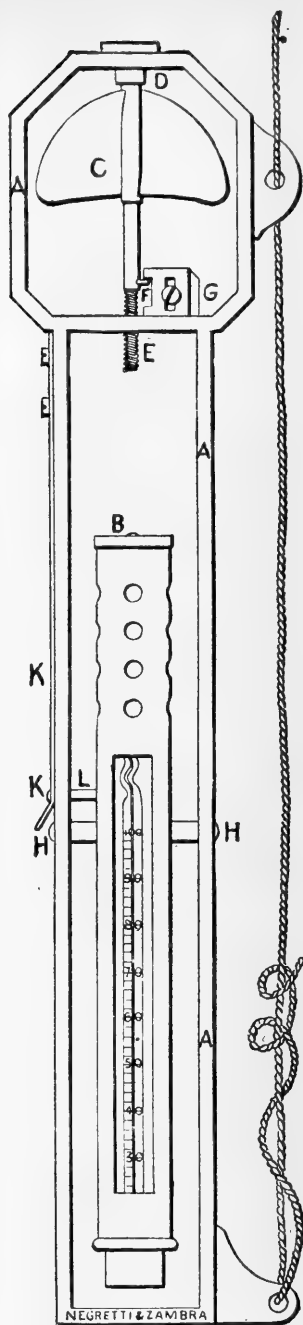


Fig. 2.



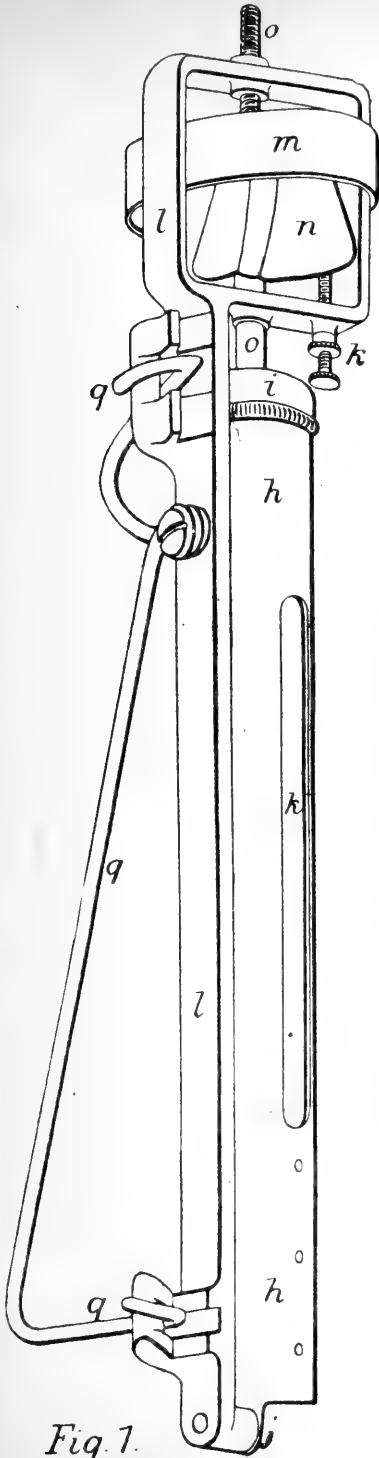


Fig. 1.

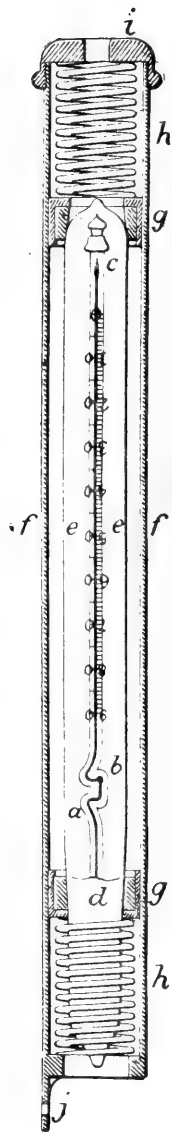
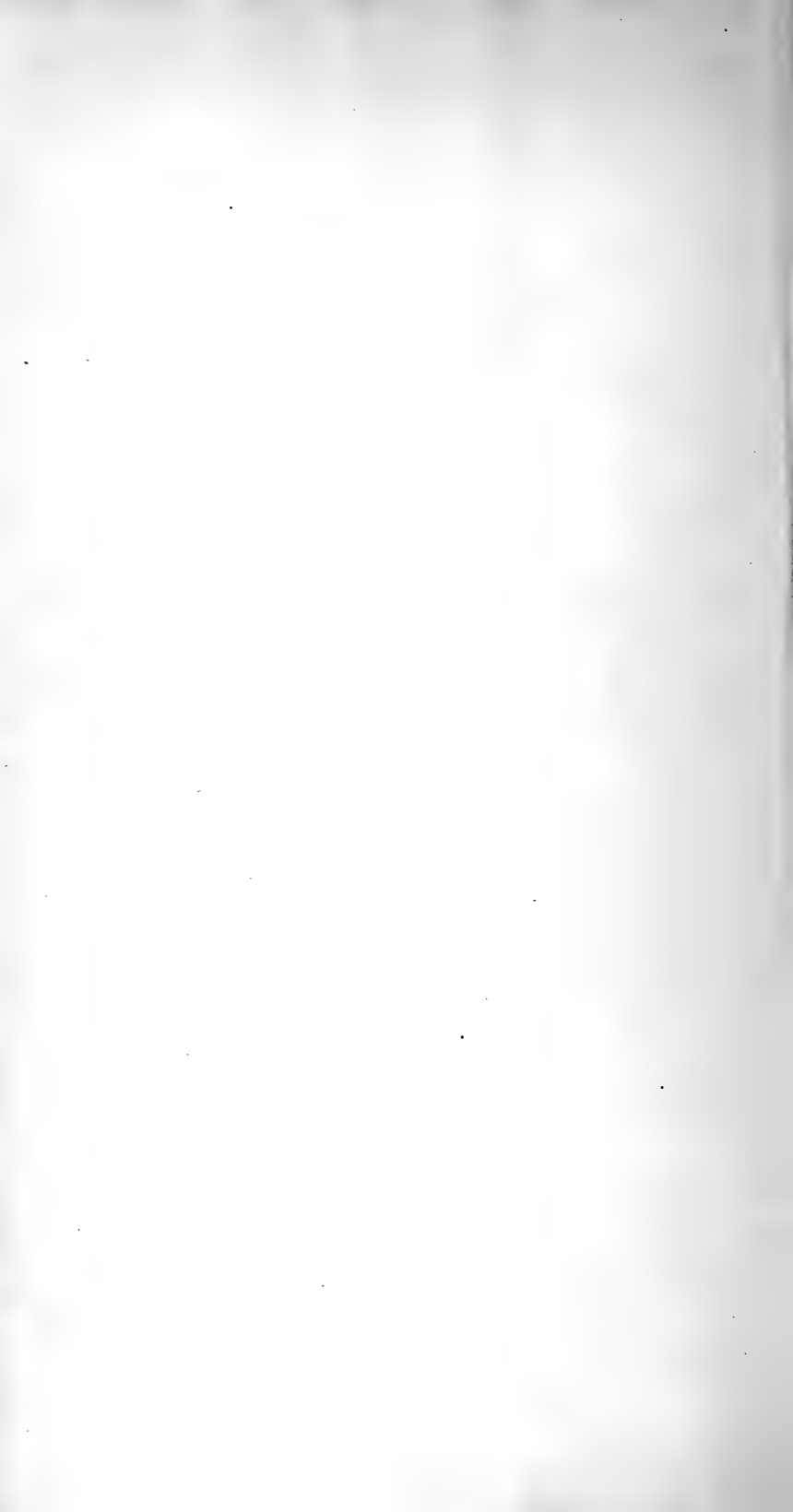
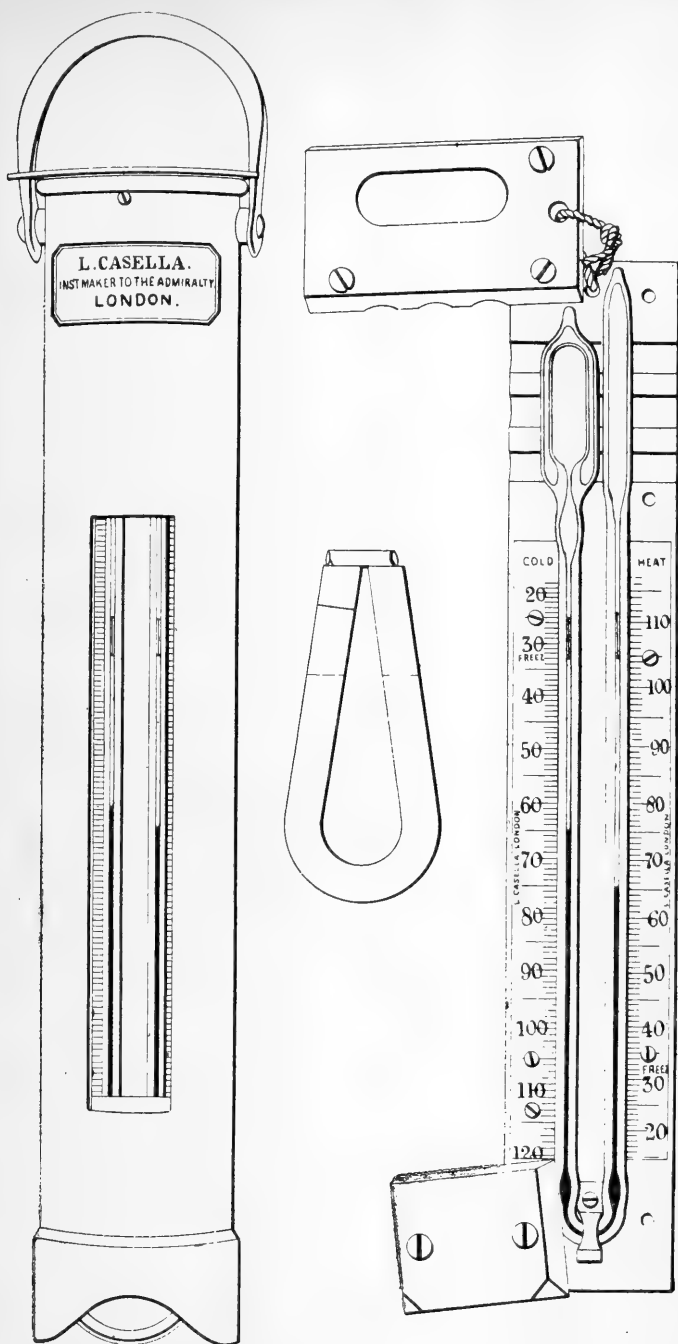


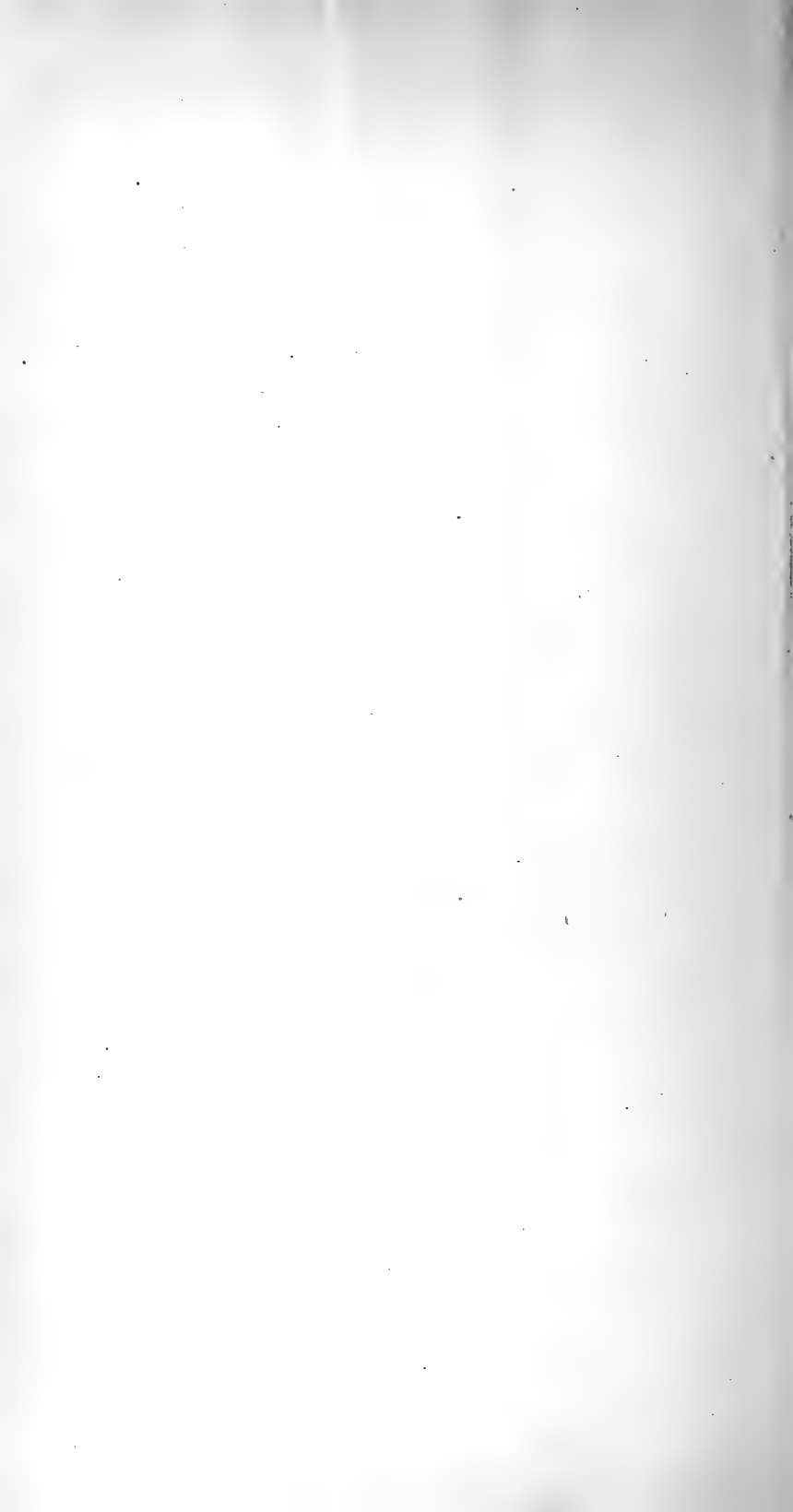
Fig 2.

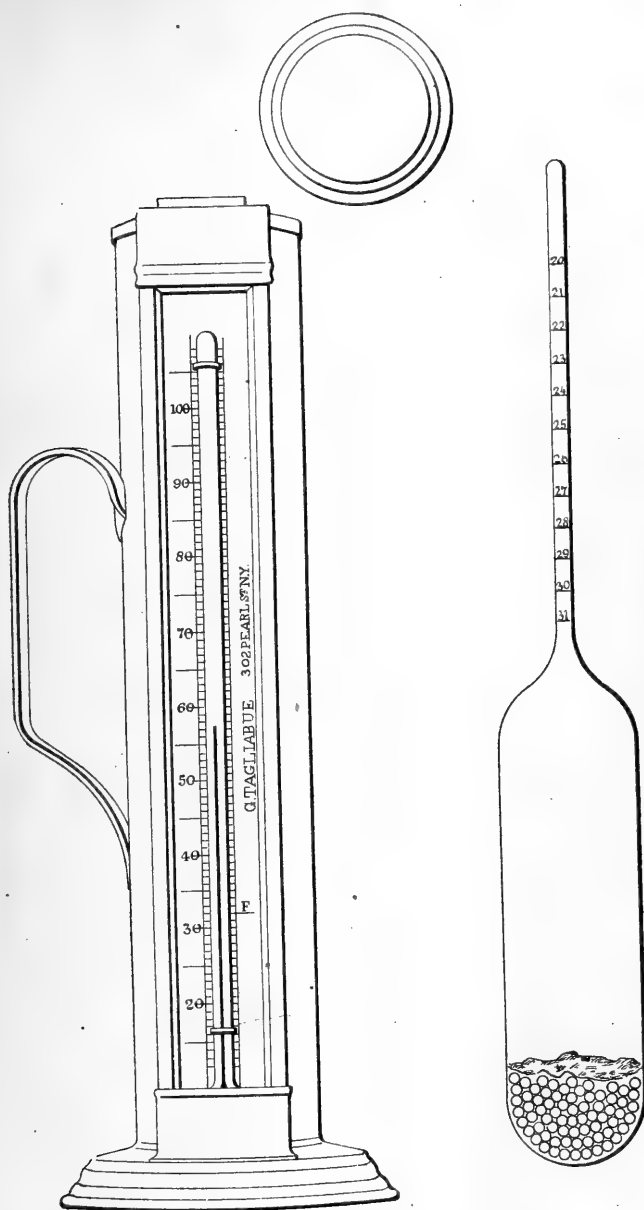
The Tanner improved thermometer case, with the Sigsbee clamp, used with the Negretti & Zambra deep-sea thermometer.



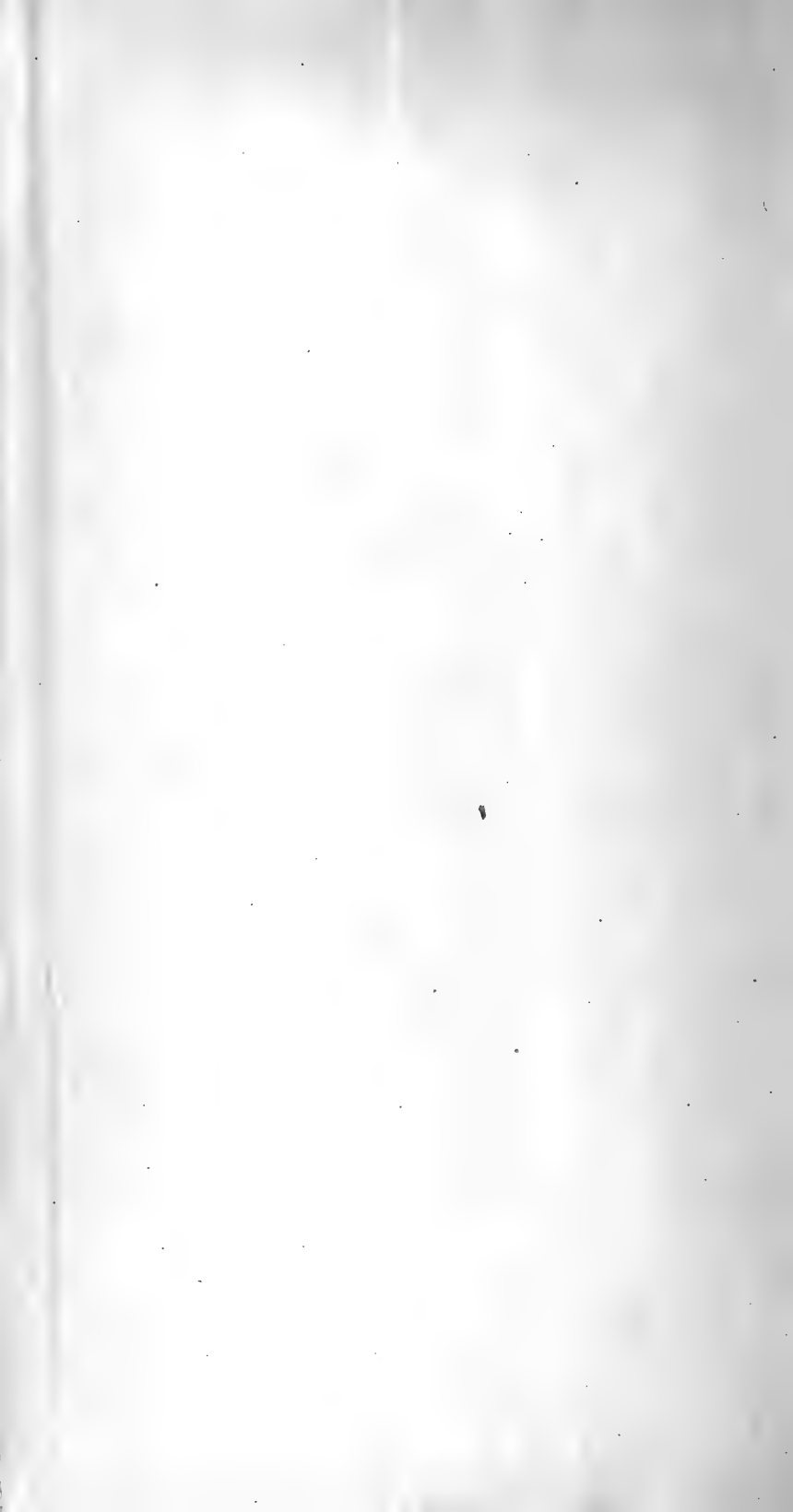


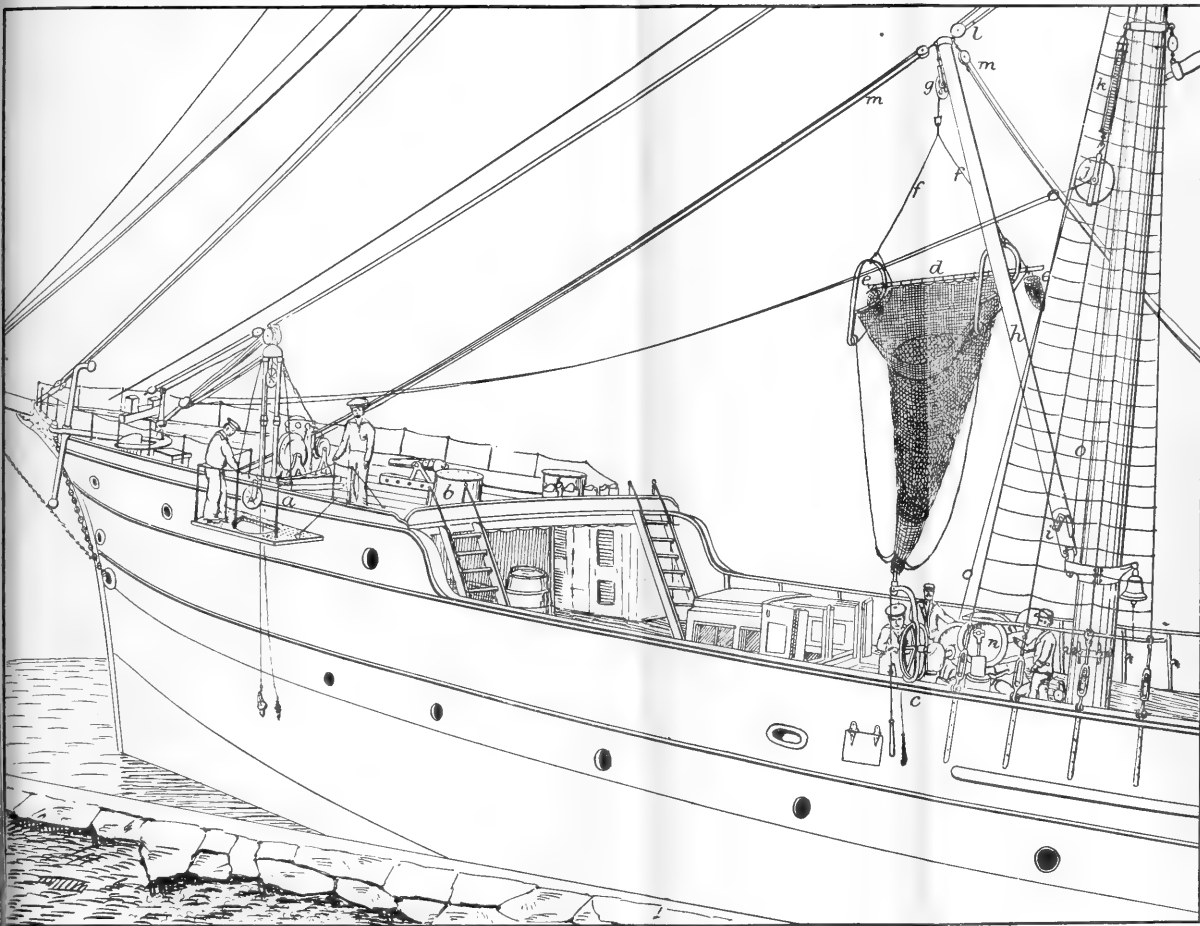
The Miller-Casella deep-sea thermometer.



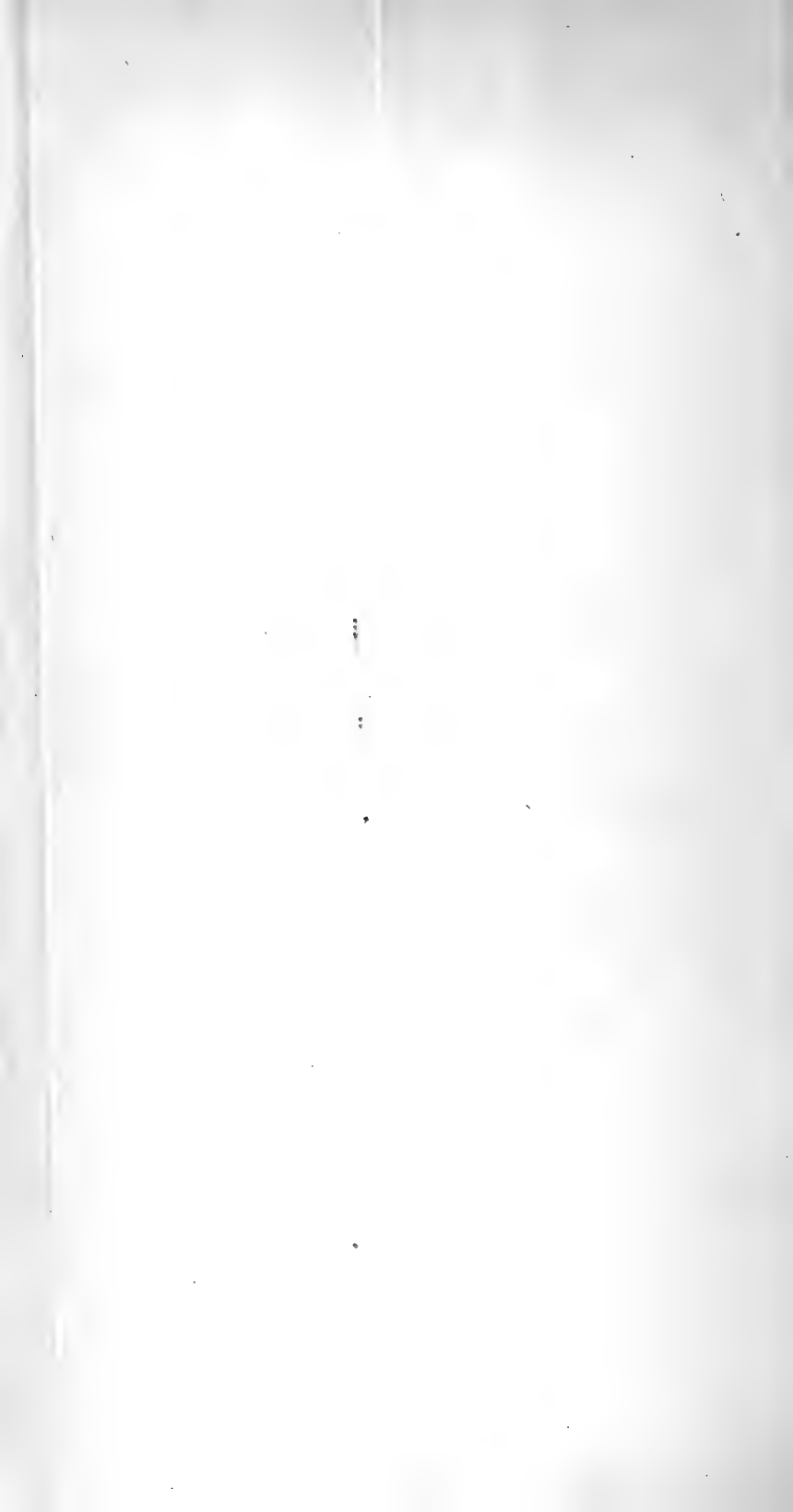


Hilgard's ocean salinometer.





The bow of the Albatross, showing the location of the dredging boom and sounding machine.



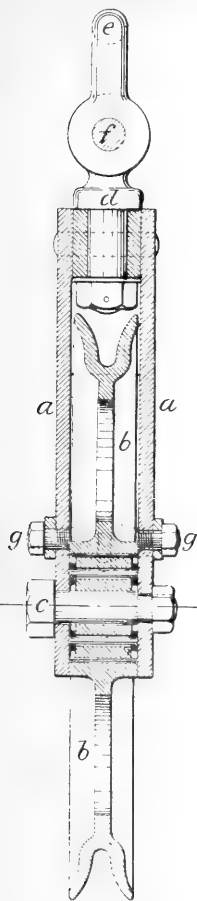


Fig 1

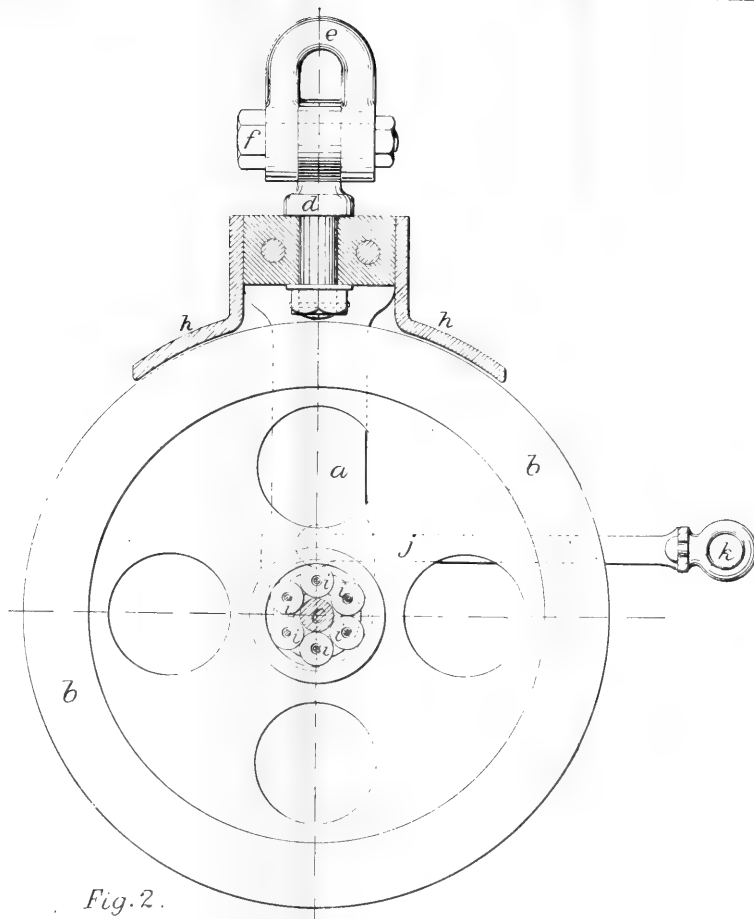
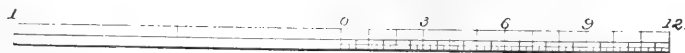
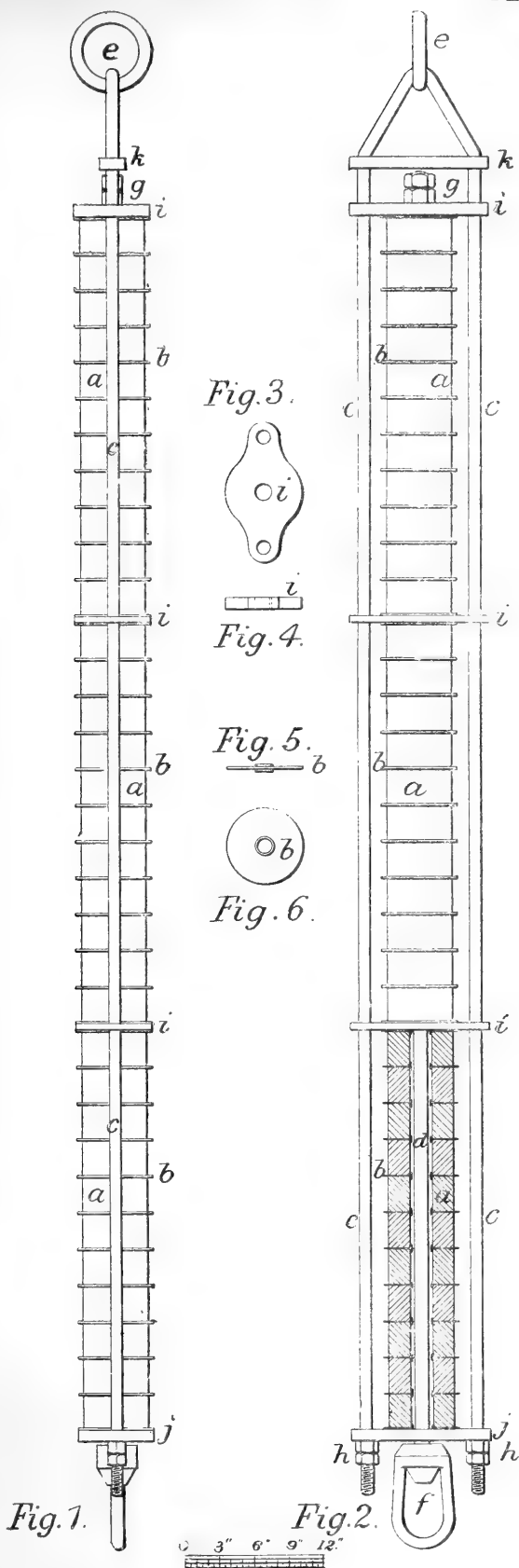


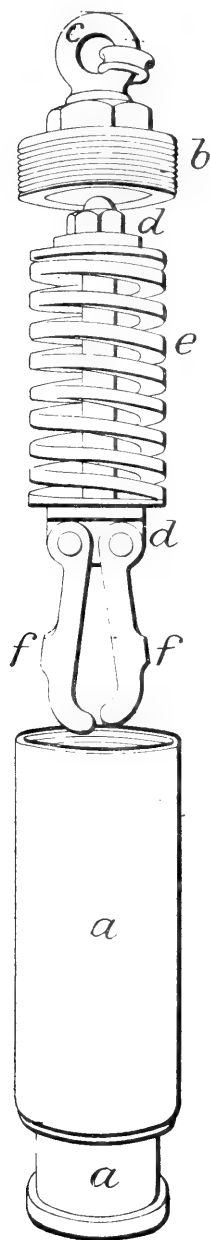
Fig. 2.



Dredging block.

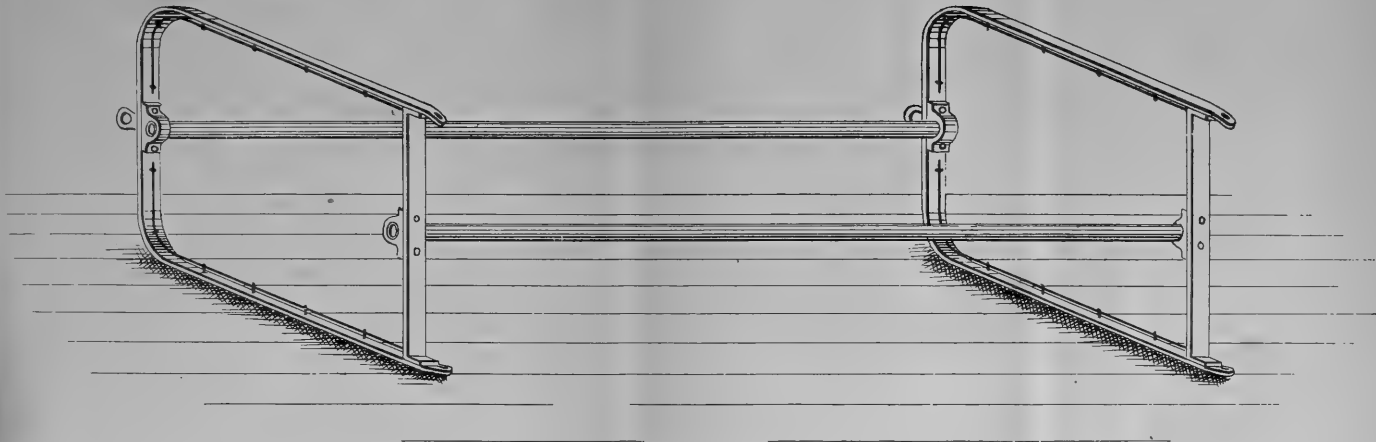


The accumulator.



Safety-hooks.





Deep-sea trawl-frame.

Scale: $\frac{1}{2}$ inch = 1 foot.

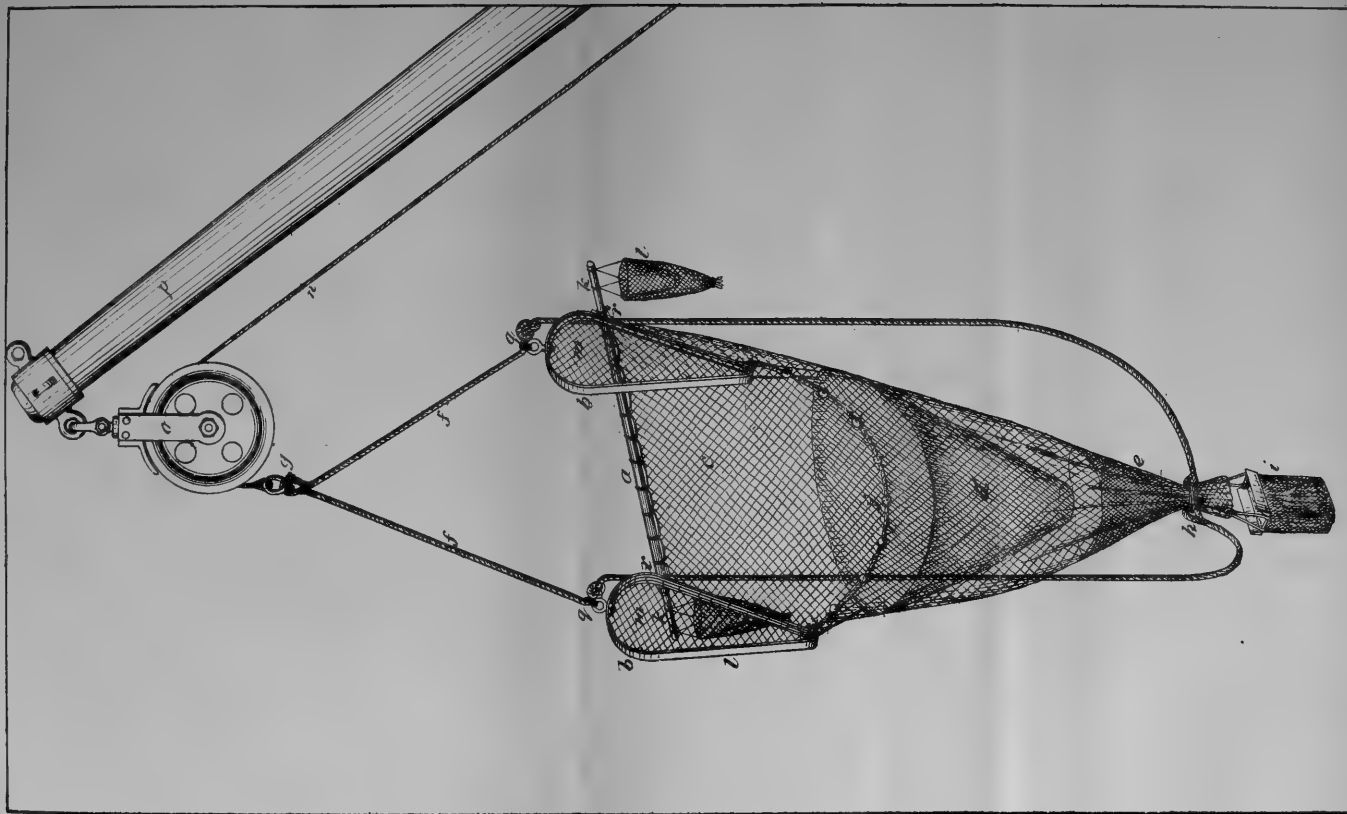




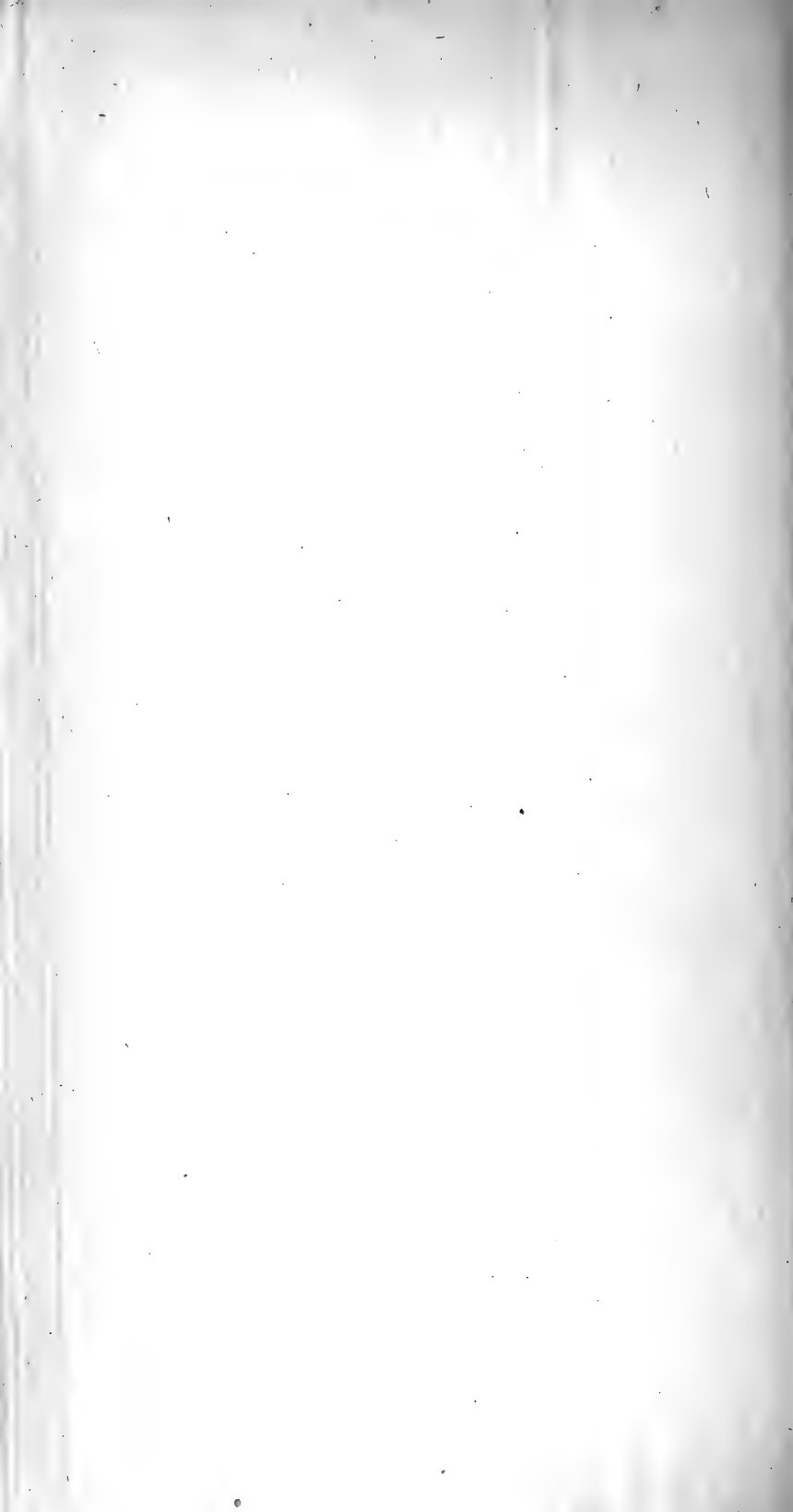
Beam-trawl frame.

Scale: $\frac{1}{2}$ inch = 1 foot.





Improved beam-trawl.



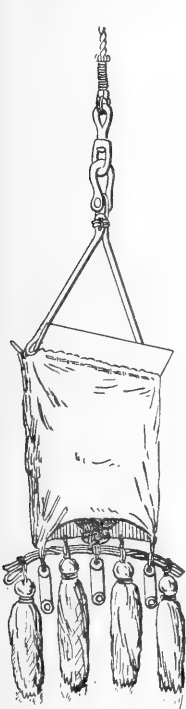


Fig. 1.

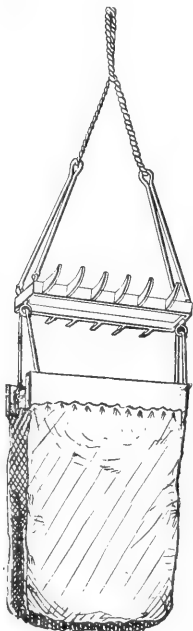


Fig. 2.

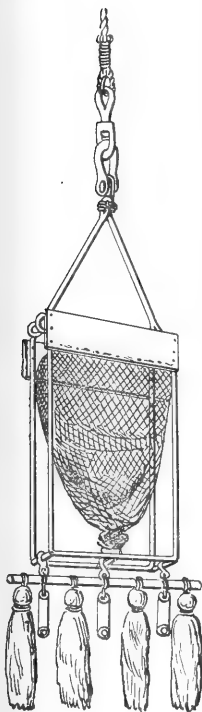


Fig. 3.

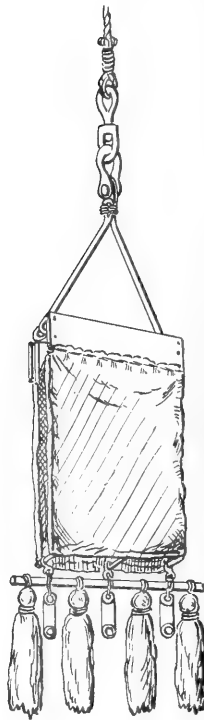
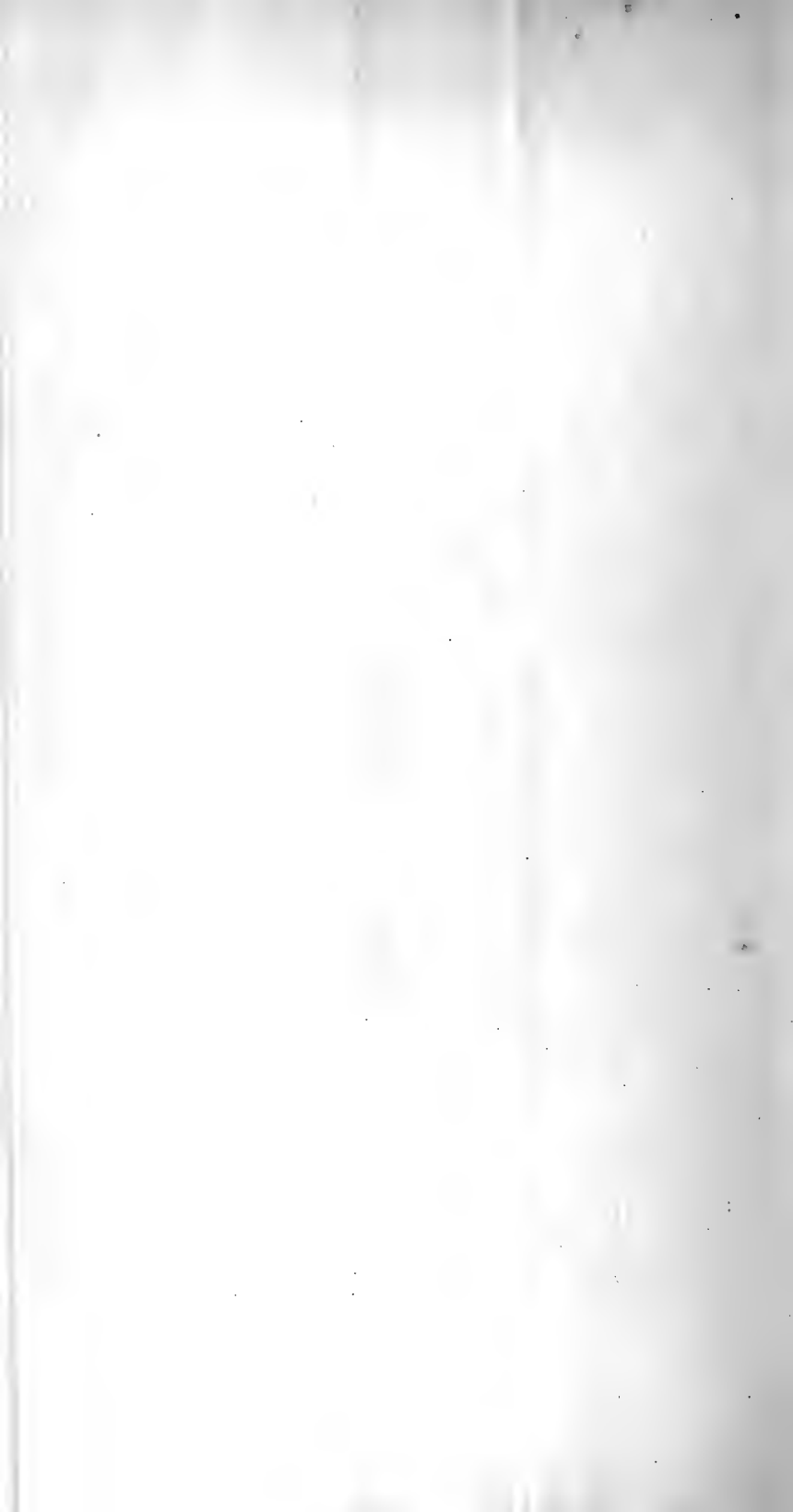
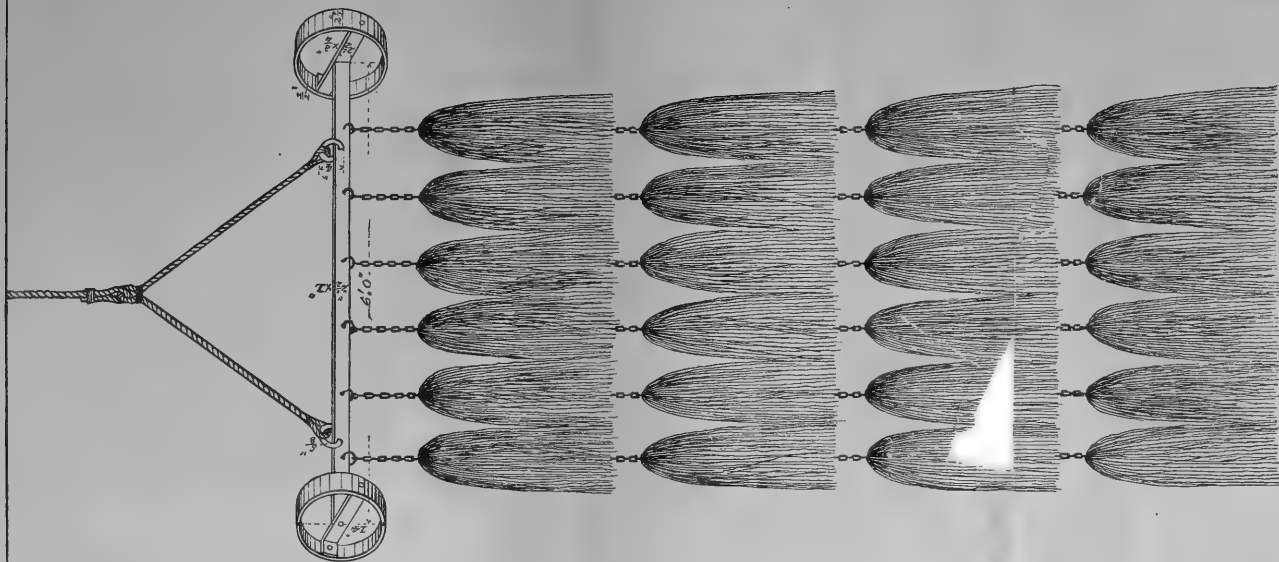


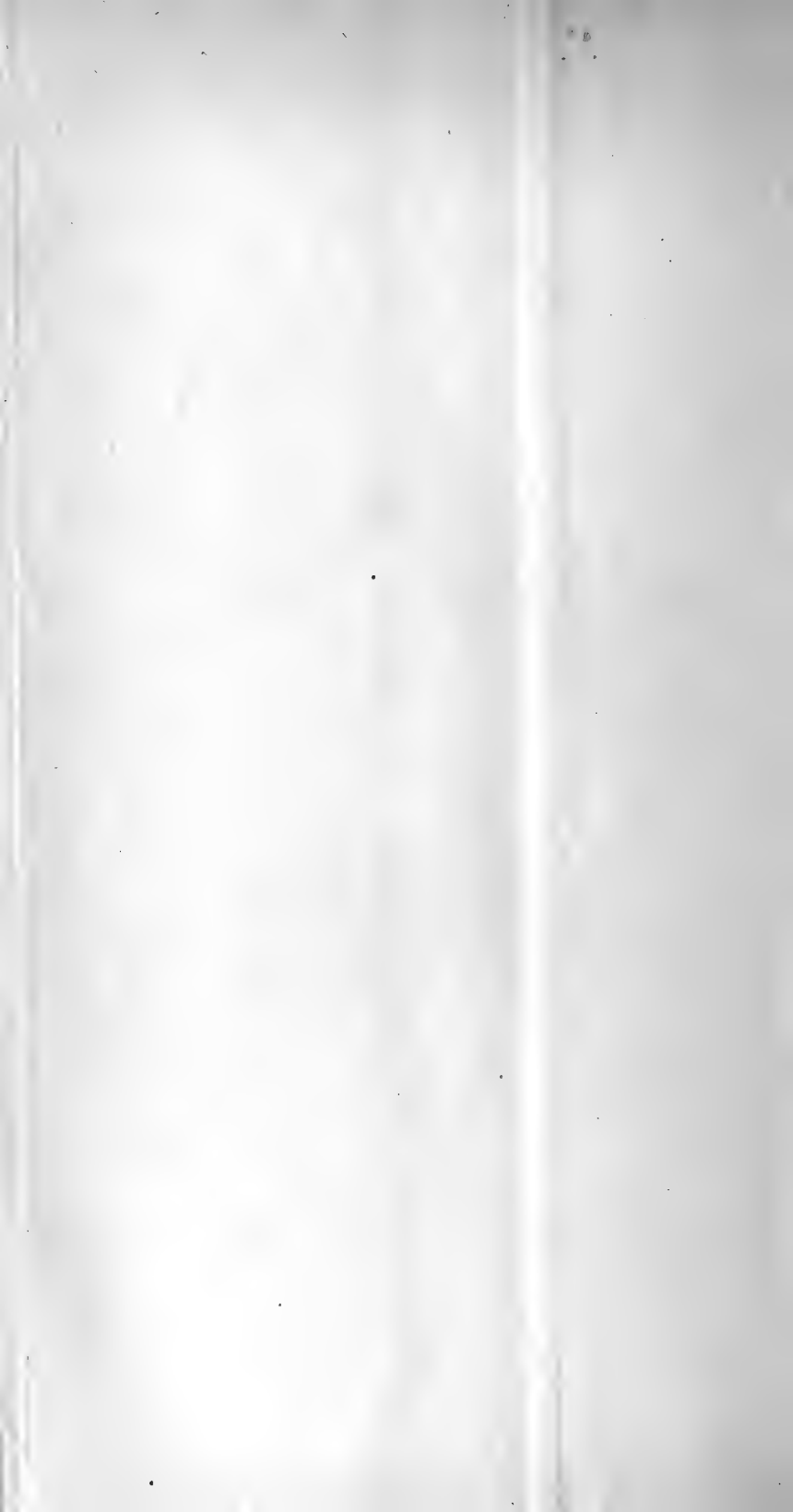
Fig. 4.

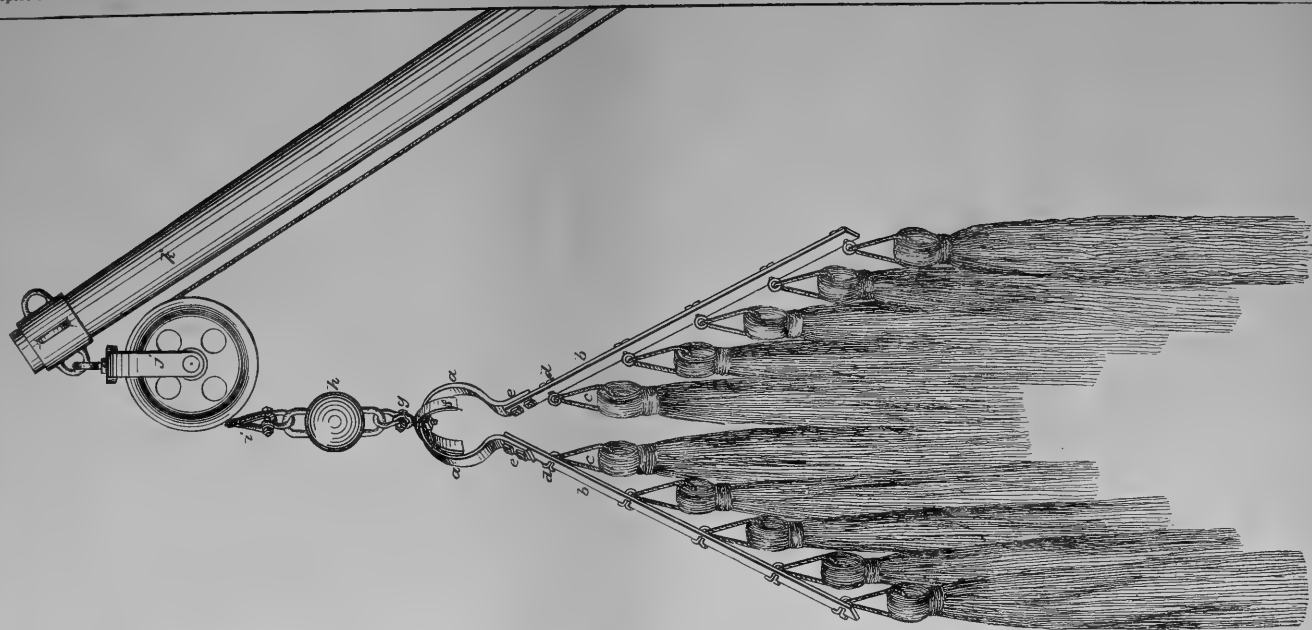
1. Common dredge. 2. Chester rake-dredge. 3 and 4. Blake dredge.



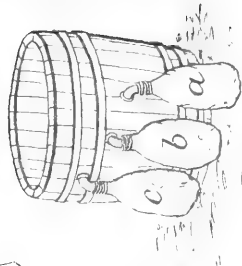
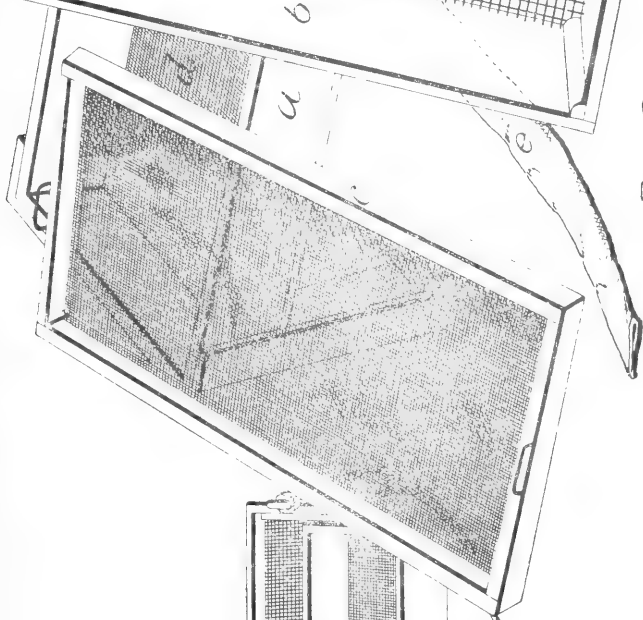
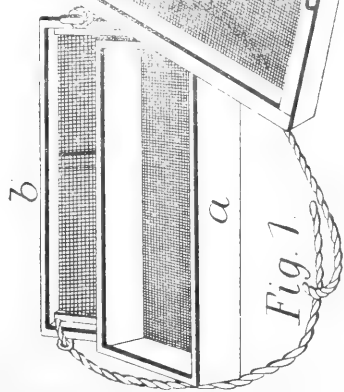


Tangle bar.

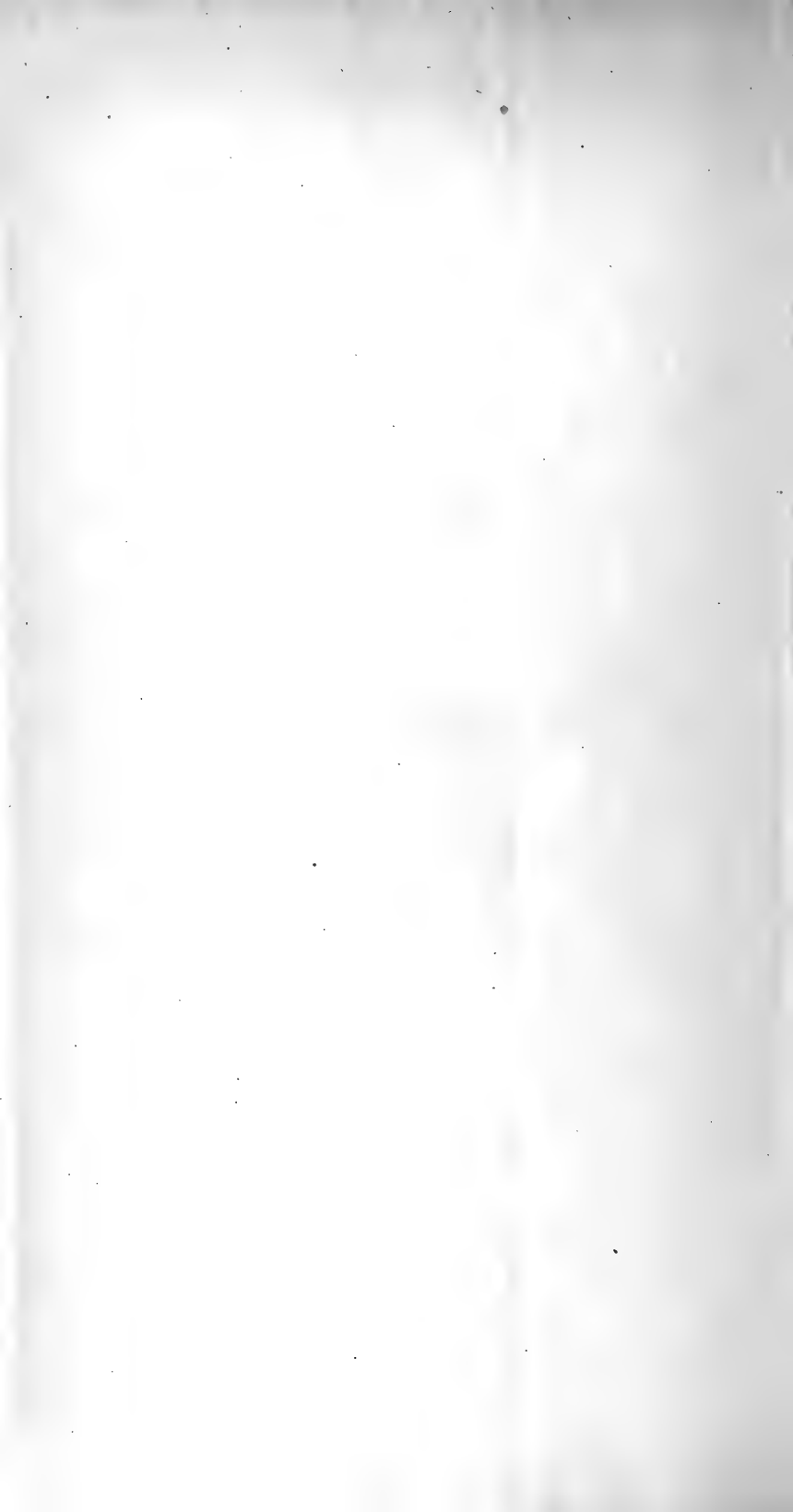


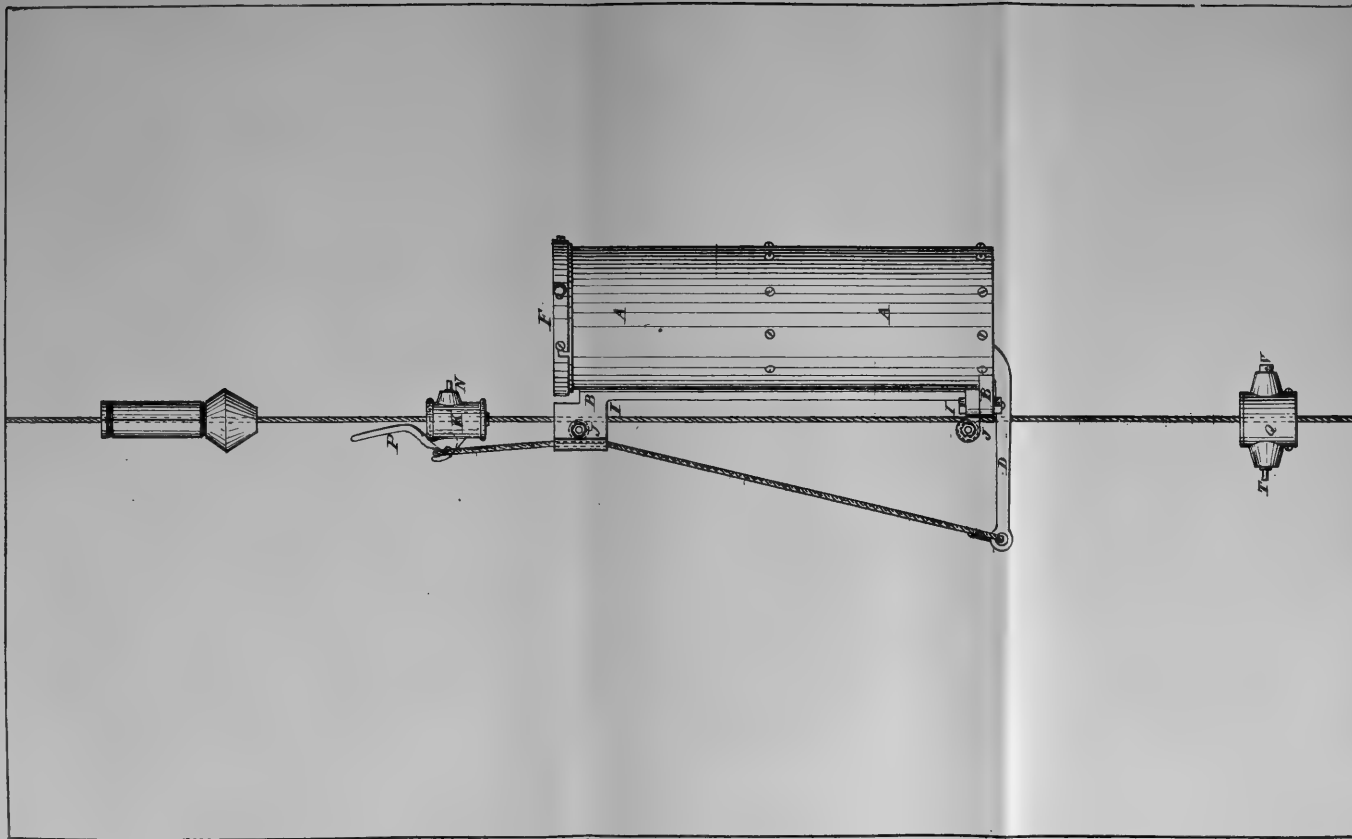


The tangles.

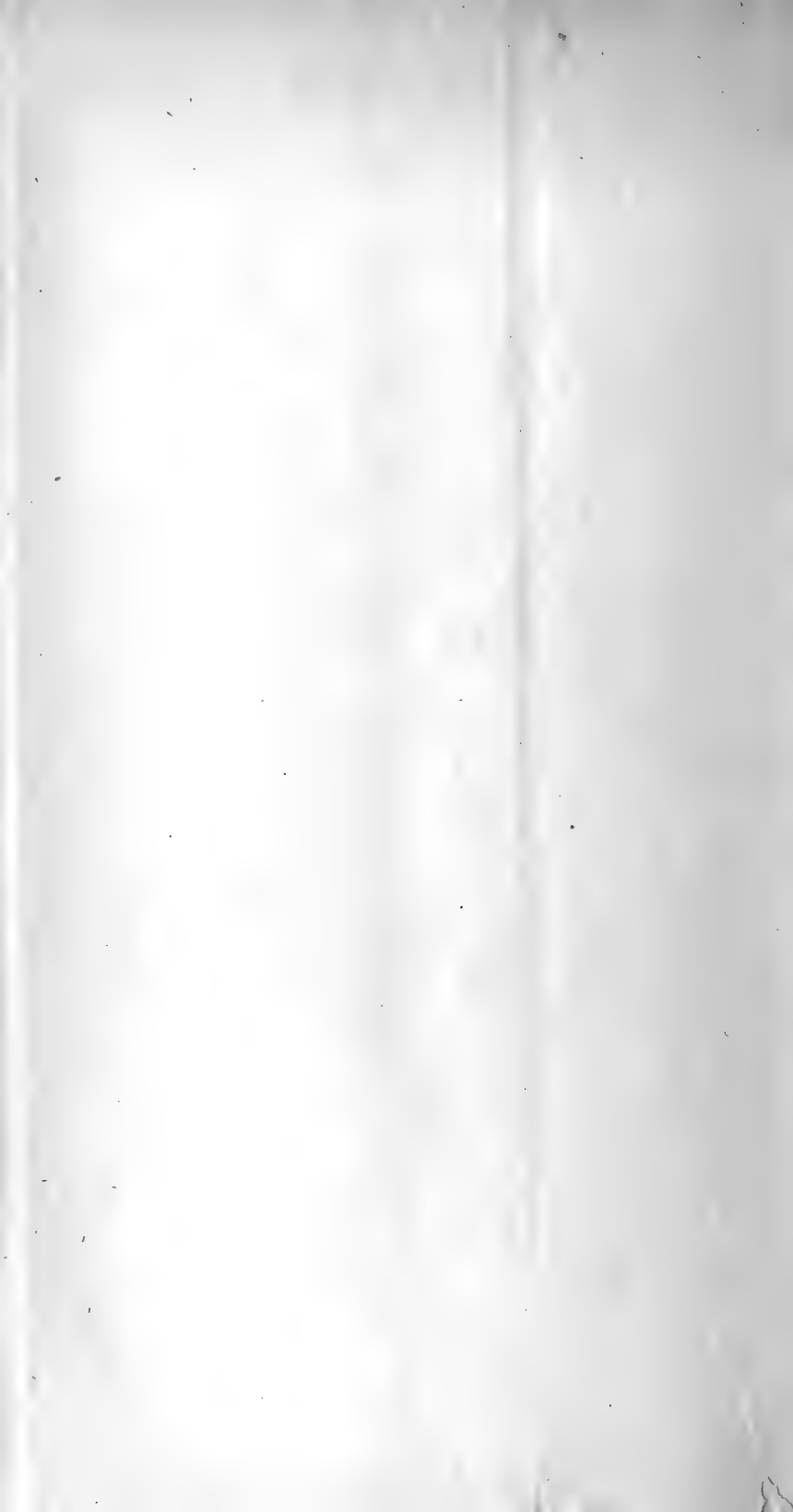


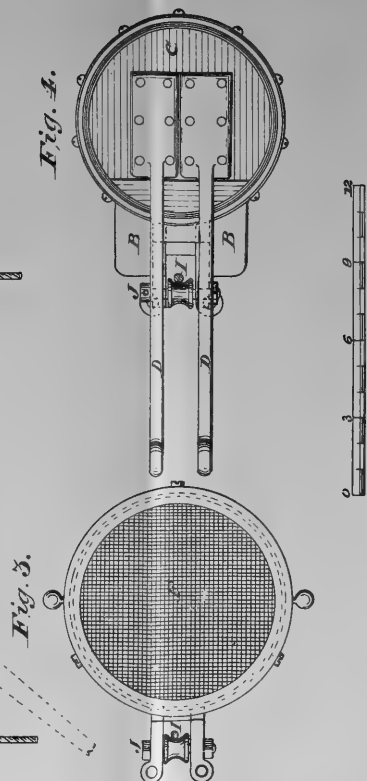
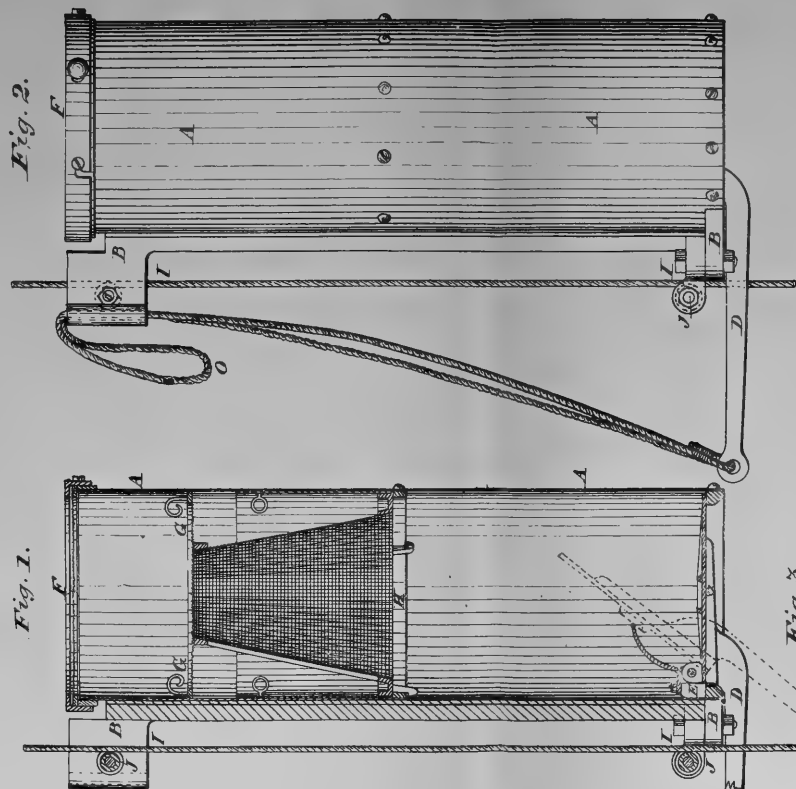
The cradle-sieve, table-sieve, and strainer.



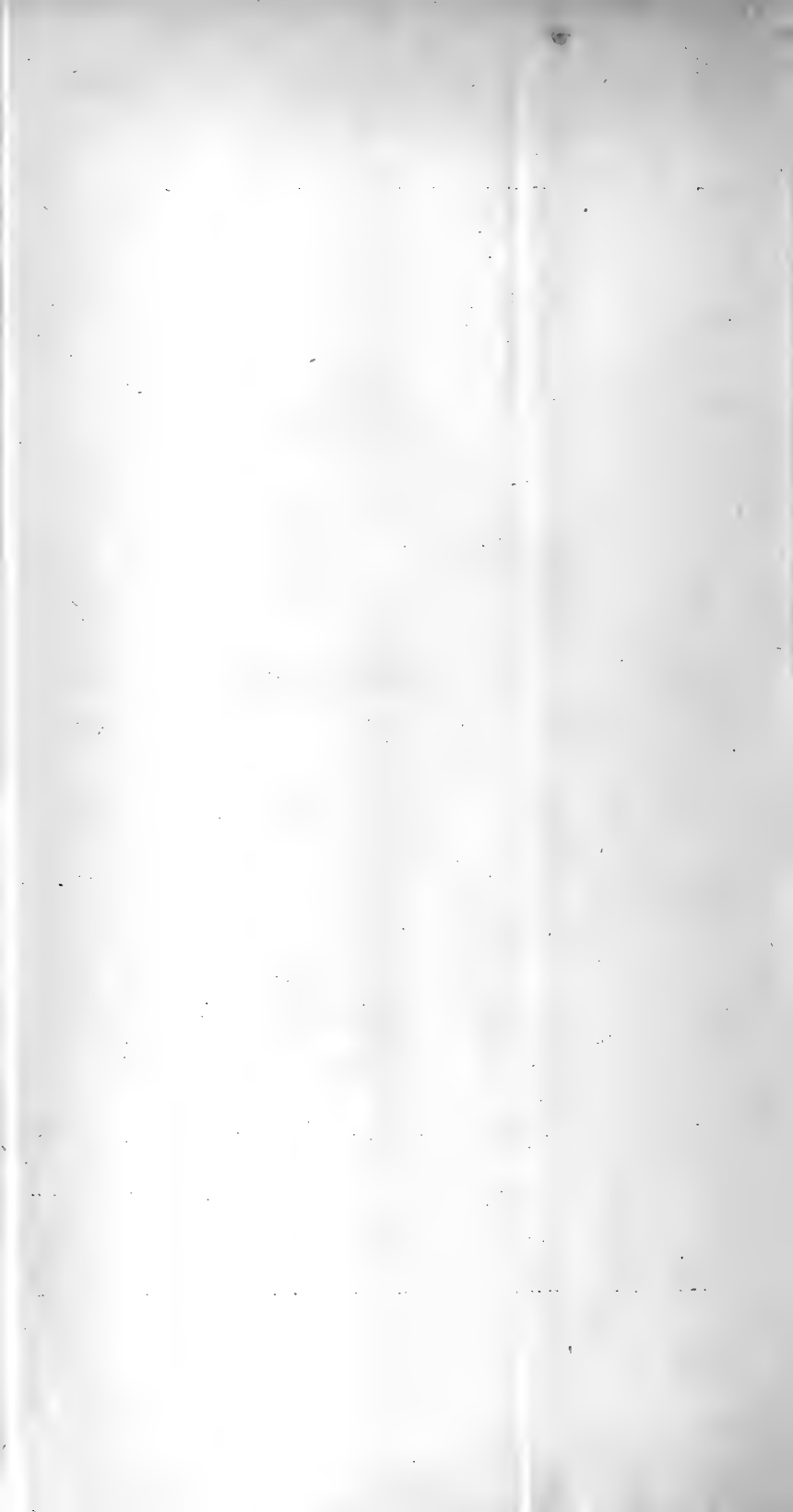


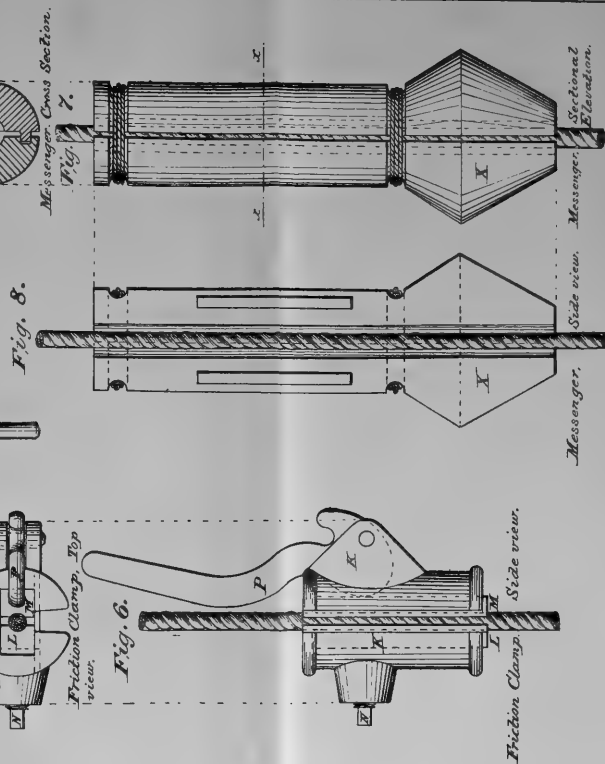
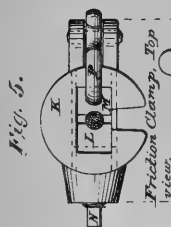
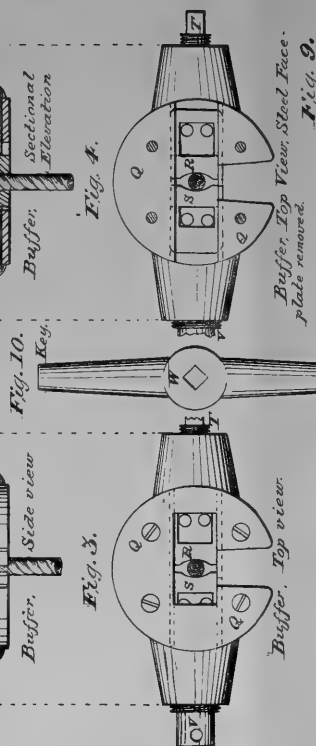
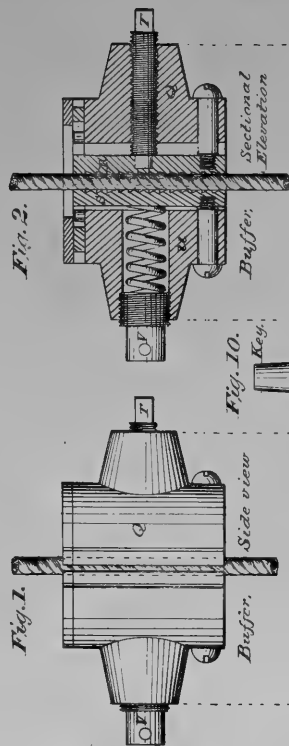
Sigsbee's gravitating trap for obtaining animal forms from intermedial ocean depths.





Sigbee's gravitating trap.—Fig. 1. Sectional elevation. Fig. 2. Side view. Fig. 3. Top view. Fig. 4. Bottom view.







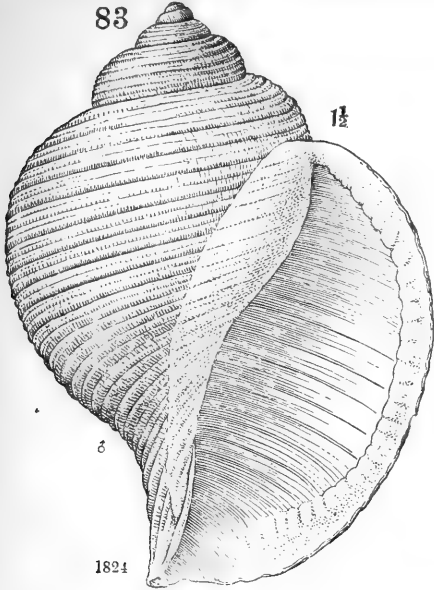
INDEX.

[NOTE.—The references are to page-figures in brackets.]

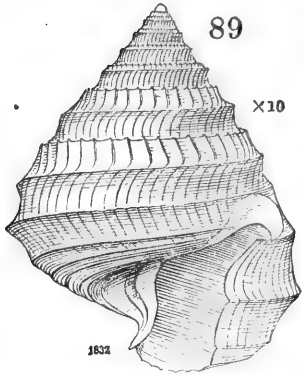
	Page.		Page.
Accumulator.....	45, 78	Bulletin of the Museum of Comparative Zoology.....	96
action during dredging.....	104	Cabin.....	7
nomenclature of.....	78	Cast-iron.....	20
Agassiz, Alexander.....	96	Chains, weight of.....	2
Air-pumps.....	18	Challenger.....	96
Albatross, boats of.....	12	Chart-room.....	8
construction of.....	2	Chester, H. C.....	84, 93
dimensions of.....	2	Chester rake dredge.....	90
dredging.....	17	Chester's wing net.....	84
launched.....	2	Circulating pump.....	21
power of.....	23	Coal, price of.....	38
specifications.....	3	Coast Survey Report.....	75
speed of.....	23	Cold-room.....	10
work begun on.....	1	Collecting apparatus, list of.....	106
American Ship Windlass Company.....	48	Condenser.....	18
Anchors, weight of.....	2	Copeland and Bacon.....	44, 46, 47, 81
Apparatus, boat-detaching.....	15	Charles W.....	1, 18
Armington and Sims.....	30	Copper pipe.....	21
Arthur, Dr. George.....	40	Correction table.....	61
Ash elevator and chute.....	28	Coupling crank.....	18
Bacon, Earle C.....	47, 81	Cradle sieve, description of.....	93
Baillie, Staff Commander.....	62	dimensions of.....	94
Baird, G. W.....	18, 55, 81	Cutter, engine of.....	43
Spencer F.....	1	Cutter, Herreshoff, steam.....	12, 13
Ballouf, D.....	54, 63, 69	Cutters, Steam.....	42
Beam trawl.....	83	Davidson light-service pump.....	18
Belknap cylinder.....	62, 63	Deck beams.....	5
Belknap, George E.....	62	Deck-house.....	6, 7
Belt tightener.....	55	Deep-sea exploration.....	17
Benedict, James E.....	94	lamps.....	38
Berth-deck.....	3, 4, 9	research, apparatus for.....	51
beams of.....	6	trawl.....	81
Blade for measuring reefs.....	60	dimensions of.....	82
Blake dredge.....	88	Deliveries.....	18
dimensions of.....	89	Detacher, Sigsbee's.....	62
steamer.....	79, 88	Dinghy.....	15
Bluefish, movements of.....	1	Distilling apparatus.....	29
Boat-detaching apparatus.....	15	Dredge, description of.....	88
Boat dredge, description of.....	90	dimensions of.....	88
dimensions of.....	90	rope.....	79
Boats, dimensions of.....	43	angle of.....	95
of Albatross.....	12	preservation of.....	80
Boilers.....	21	scope of.....	95
dimensions of.....	21	Dredging.....	17
weights in.....	22	block.....	77
Brass tubes.....	21	description of.....	103
Brig.....	10	engine.....	44, 80
Bronze castings.....	20	power of.....	45
Brooke, John M.....	62		

	Page.		Page
Dredging quadrant, description of	94	Keelsons	
Drum-room	8	intercostal	
Dynamo	31	Kidder, J. H.	68, 69
Dynamometer	45, 78	Kitchen	
Economy of electric lighting	35	Laboratory, lower	
Edison, Thomas A	30, 31	outfit	108
Electric lighting, cost of	37	list of	107
economy of	35	upper	
Engine, Armington & Sims	30	Lamp fixtures	71
dredging	44, 80	for soldering sounding-wire	56
hoisting	81	Lamps, deep-sea	58
of cutter	43	electric	53
reeling	46, 80, 81	Library, contents of	106
room, upper	8	Lighting	29
sounding	47	cost of	37
Engines, dimensions of	19	Limber-hole	
motive	18	Machinery, dimensions of	45
weight of	20	Mackerel, movements of	1
Equipment and Recruiting, Bureau of	109	Magazine	10
Exhaust fan, Sturtevant	39	Magnaghi, Commander	71
Fan-motor, economy of	41	Main deck	3, 4
power of	41	ties of	1
Fish Hawk	96	May, Sidney H.	59
steamer	55, 80	Measuring reel	60
Fish line rigged for use	106	wire	60
Fishing, apparatus used in	106	Mechanical appliances	11
gear, list of	106	Menhaden, movements of	7
Flint, J. M.	68, 69	Mess furniture, remarks on	109
Floors	4	Miller-Casella deep-sea thermometer	73, 74
Food-fishes, decrease of	1	Mud bag	8
Fore hold	10	Naval Institute, proceedings of the	40
Forecastle deck	3	Navigation, Bureau of	106
top-gallant	9	Navy Department, co-operation of	104
Forgings, iron	20	Negretti & Zambra's thermometer	69, 71, 74, 106
steel	21	Nets, list of	109
Frames	4	dip, list of	109
Gibbs, Wolcott	76	scoop, list of	107
Gig, Herreshoff steam	14	New York Rubber Belting Company	71
steam	12	Nomenclature of accumulator	71
Gipsy head	45	gravitating trap	99
Governor	47, 81	improved beam trawl	86
Governors, Svedberg	25	water-bottle	67
Gravitating trap, Sigsbee's	96, 97, 99	Sigsbee's detacher	62
Green, J. & H. J.	73	sounding machine	56
Hazard Manufacturing Co.	79	tangles	91
Herreshoff Manufacturing Co.	12, 42	thermometer case	71
Higgins & Gifford	15	water-specimen cup	64
Higginson & Co.'s steam quartermaster	16	Ocean salinometer, Hilgard's	75
Higginson, Andrew	50	Ordnance, Bureau of	109
Hilgard, J. E.	75	Ordnance department, navy-yard	63, 79
Hilgard's ocean salinometer	75	Outfit, remarks on	104
Hoisting engine	81	Phosphor-bronze castings	20
Hold, fore	10	Piano-forte wire for sounding	58
Hold stringers	6	Pilot-house	9
Holds	4	Plating	9
Hot well	39	Pop-house deck	4
Hubbard, J. S.	76	Power, absorption of	25
Hull	4	distribution of	24, 30
Hull, friction of	25	Proceedings of the Naval Institute	60
Hydra machine	62	Pump, details of	27
Ice boxes	5	Sprengel	33
Injectors	27	Pumps, steam	27
Iron forgings	20	Pusey and Jones Company	1, 2, 16, 18, 50
Isherwood, Chief Engineer	25	Quartermaster, steam, Higginson & Co.'s	16
Keel	4	Radiators	38

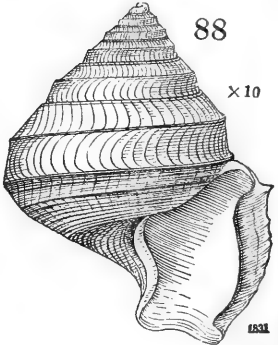
83



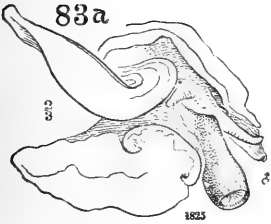
89



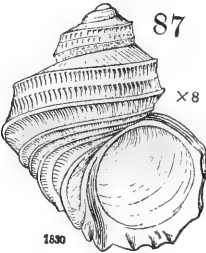
88



83a



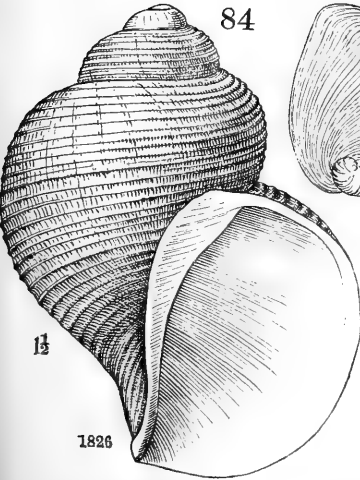
87



85a



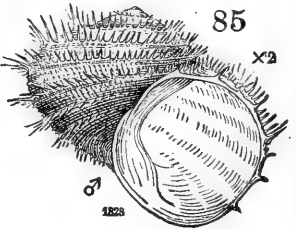
84



a



85



84b

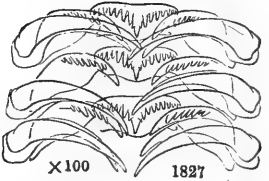
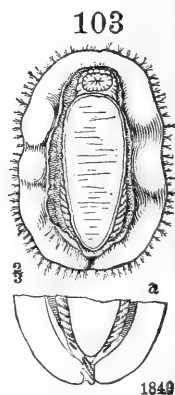
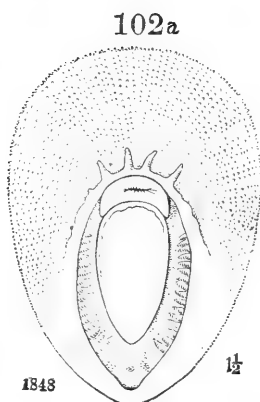
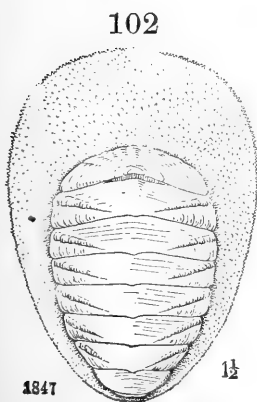
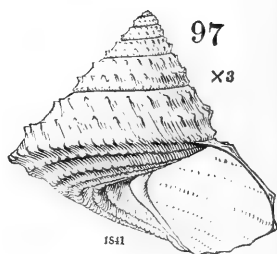
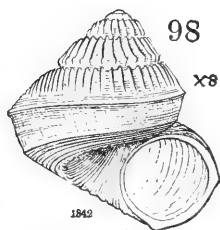
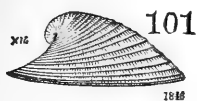
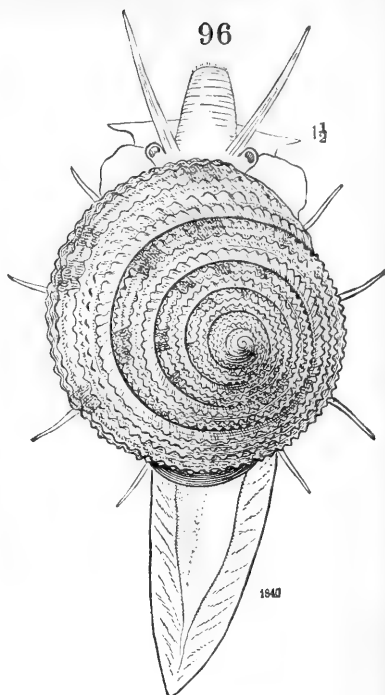
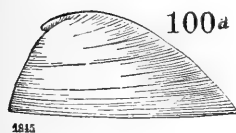
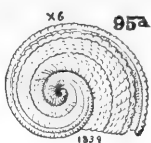
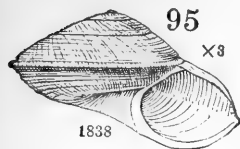
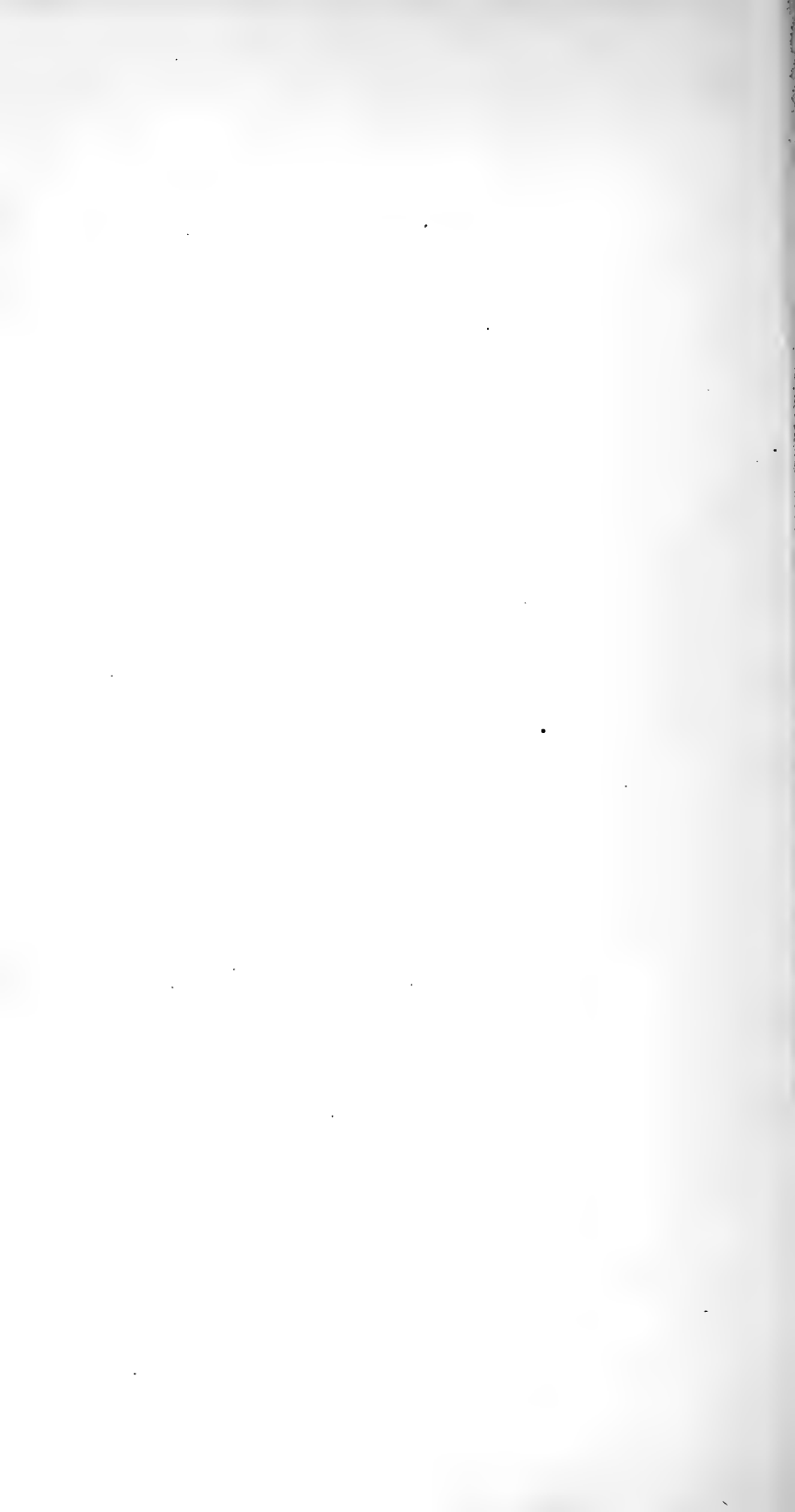




PLATE XXVII.

- FIG. 95. *Solarium boreale*, enlarged three diameters.
FIG. 95 a. The same. Upper surface of a young specimen, enlarged six diameters.
FIG. 96. *Calliostoma Bairdii* V. & S. Dorsal view of the living animal and shell, enlarged one and one-half diameters.
FIG. 97. *Margarita regalis* V. & S., enlarged three diameters.
FIG. 98. *Margarita lamellosa* V. & S., enlarged eight diameters.
FIG. 99. *Cyclostrema Dalli* V., enlarged ten diameters.
FIG. 100. *Addisonia paradoxa*. Female. Ventral view of the animal and shell in alcohol, enlarged three diameters.
FIG. 100 a. The same. Side view of the shell, enlarged about two diameters.
FIG. 101. *Cocculina leptalea* V. Side view, much enlarged.
FIG. 102. *Placophora Atlantica*. Dorsal view, enlarged one and one-half diameters.
FIG. 102 a. The same specimen. Ventral view.
FIG. 103. *Amicula Emersonii*. Ventral view, two-thirds natural size; a, the posterior end, more enlarged.
FIG. 104. *Turbonilla Rathbuni* V. & S., enlarged four diameters.





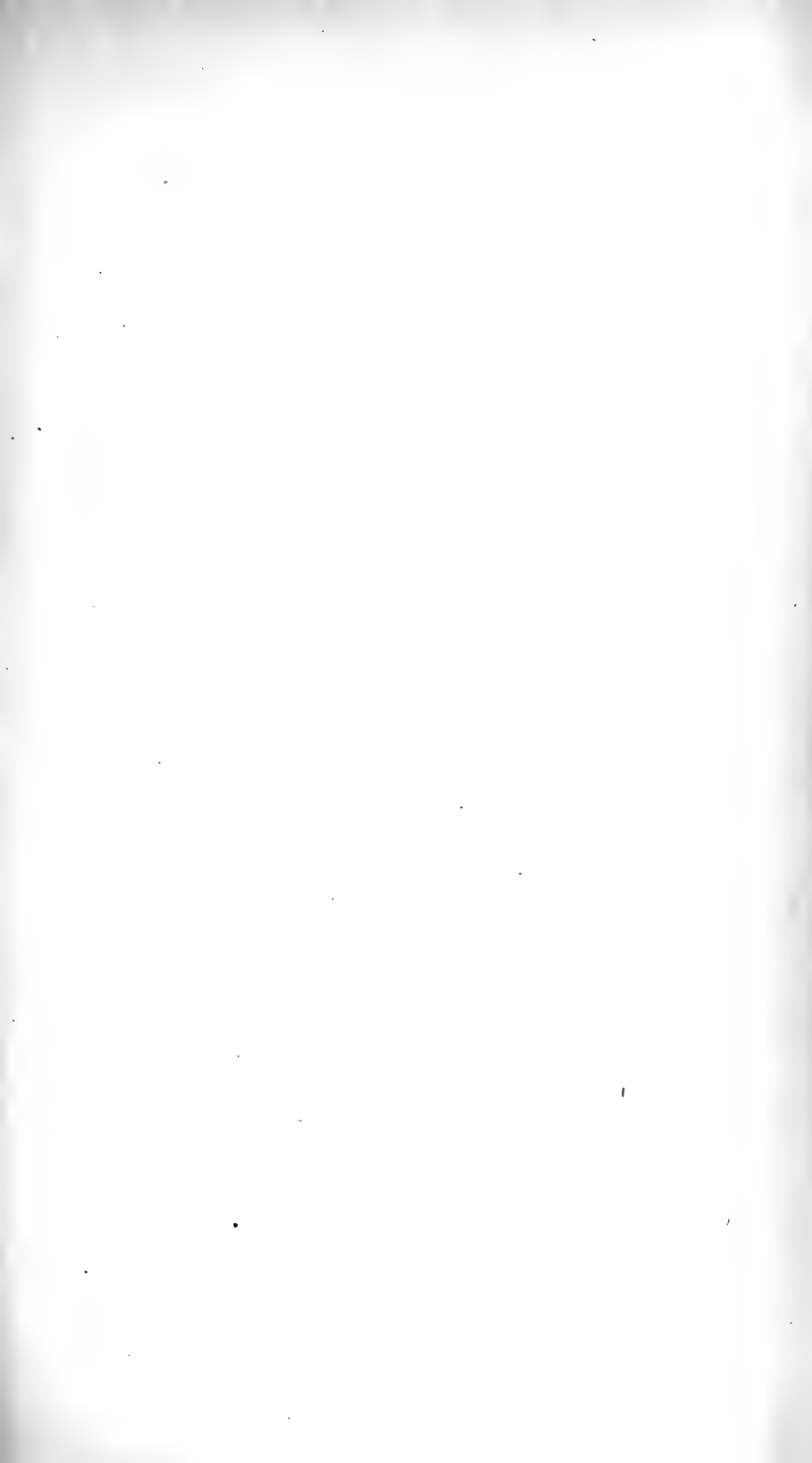
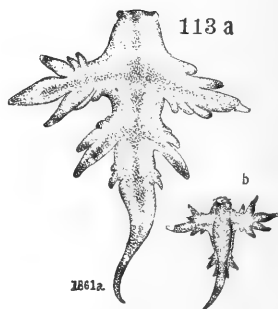
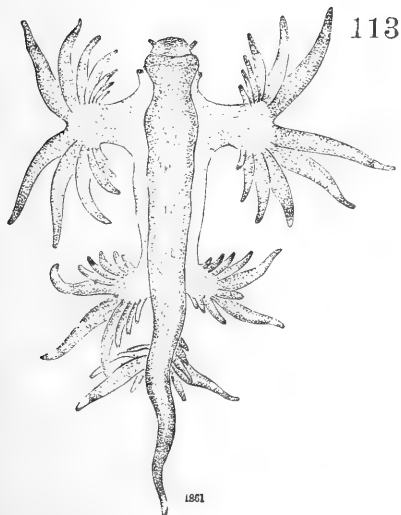
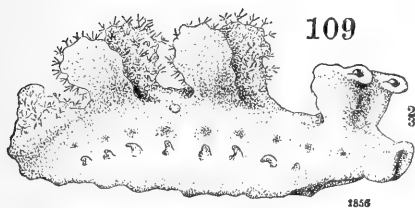
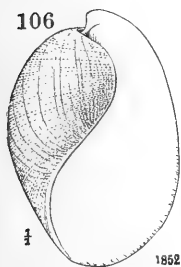
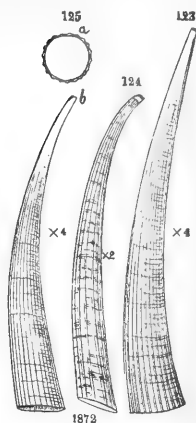
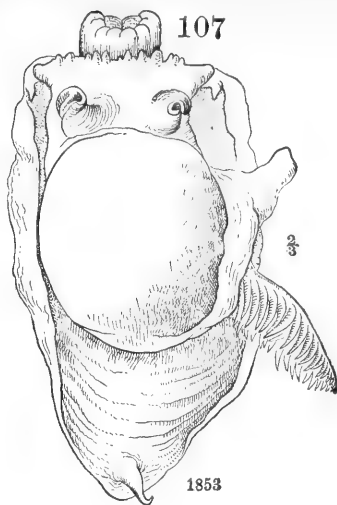
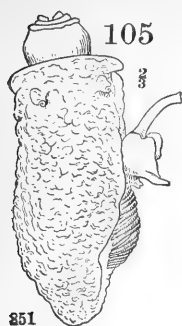
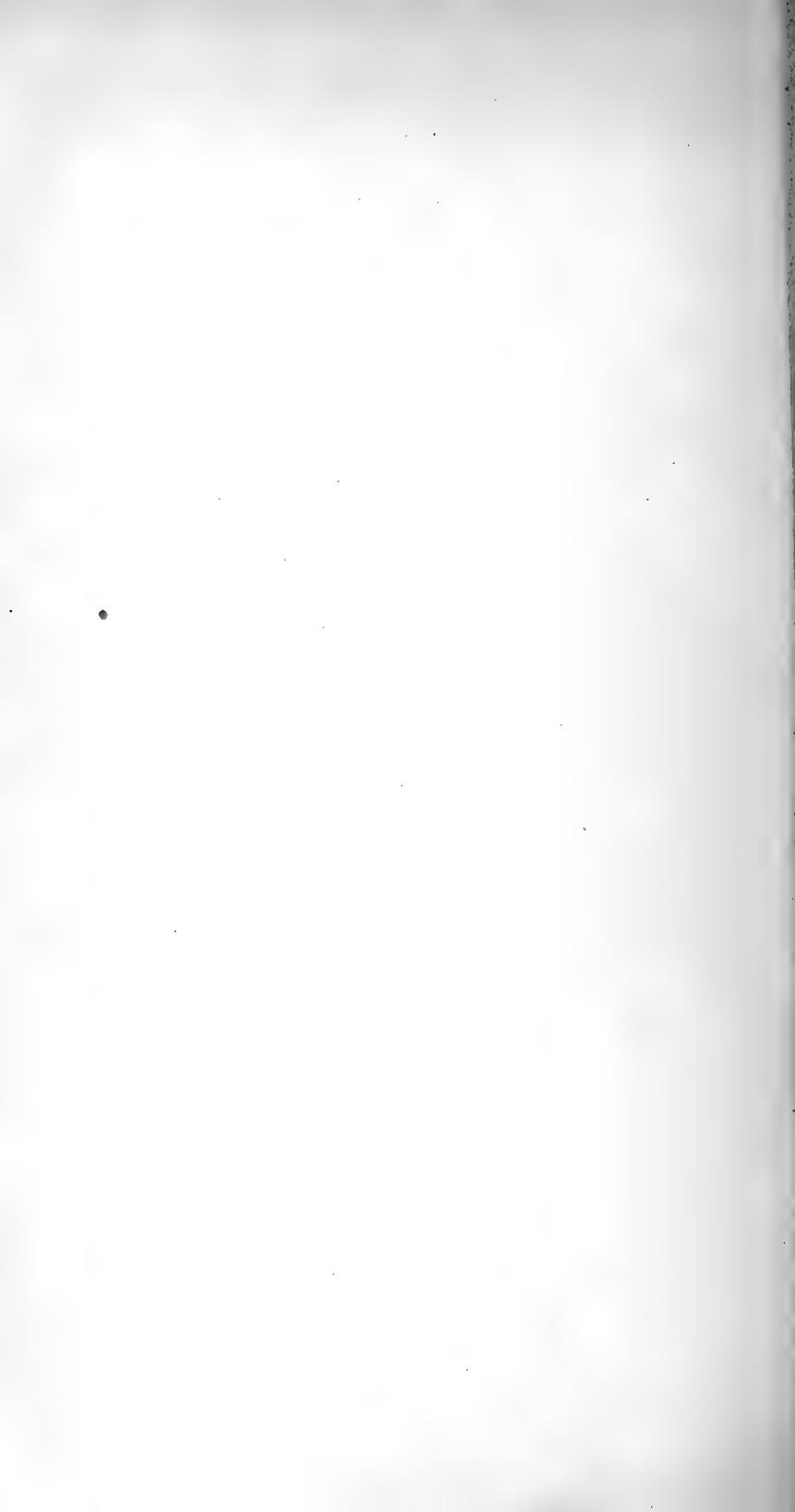


PLATE XXVIII.

- FIG. 105. *Pléurobranchæa tarda* V. Dorsal view of a specimen in alcohol, two-thirds natural size.
- FIG. 106. *Scaphander nobilis* V., natural size.
- FIG. 107. *Koonsia obesa* V. Dorsal view of a specimen preserved a short time in alcohol, in which the dorsal part of the body is much contracted, two-thirds natural size.
- FIG. 108. *Issa ramosa* V. & Em. Dorsal view of a living specimen, enlarged three diameters.
- FIG. 108 a. The same. Part of the odontophore, much enlarged.
- FIG. 109. *Scyllæa Edwardsii* V. Side view of a living specimen, two-thirds natural size.
- FIG. 113. *Glaucus margaritaceus*. Ventral view of a nearly mature specimen, considerably enlarged.
- FIG. 113 a. The same. Dorsal view of a younger specimen, much enlarged; b, view of a still smaller specimen.
- FIG. 123. *Dentalium occidentale*, enlarged four diameters.
- FIG. 124. The same. A small specimen of a more curved variety, enlarged two diameters.
- FIG. 125. The same. View of a young specimen with more numerous sulcations, enlarged four diameters; a, transverse section of the same.
- FIG. 126. *Cadulus Pandionis* V. & S., enlarged about three diameters; a, front view of the anterior end to show the aperture.
- Fig. 109 was drawn from life by Ensign W. E. Safford, U. S. N.
- Figs. 113 and 113 a were copied from sketches made at sea by Mr. A. Baldwin.





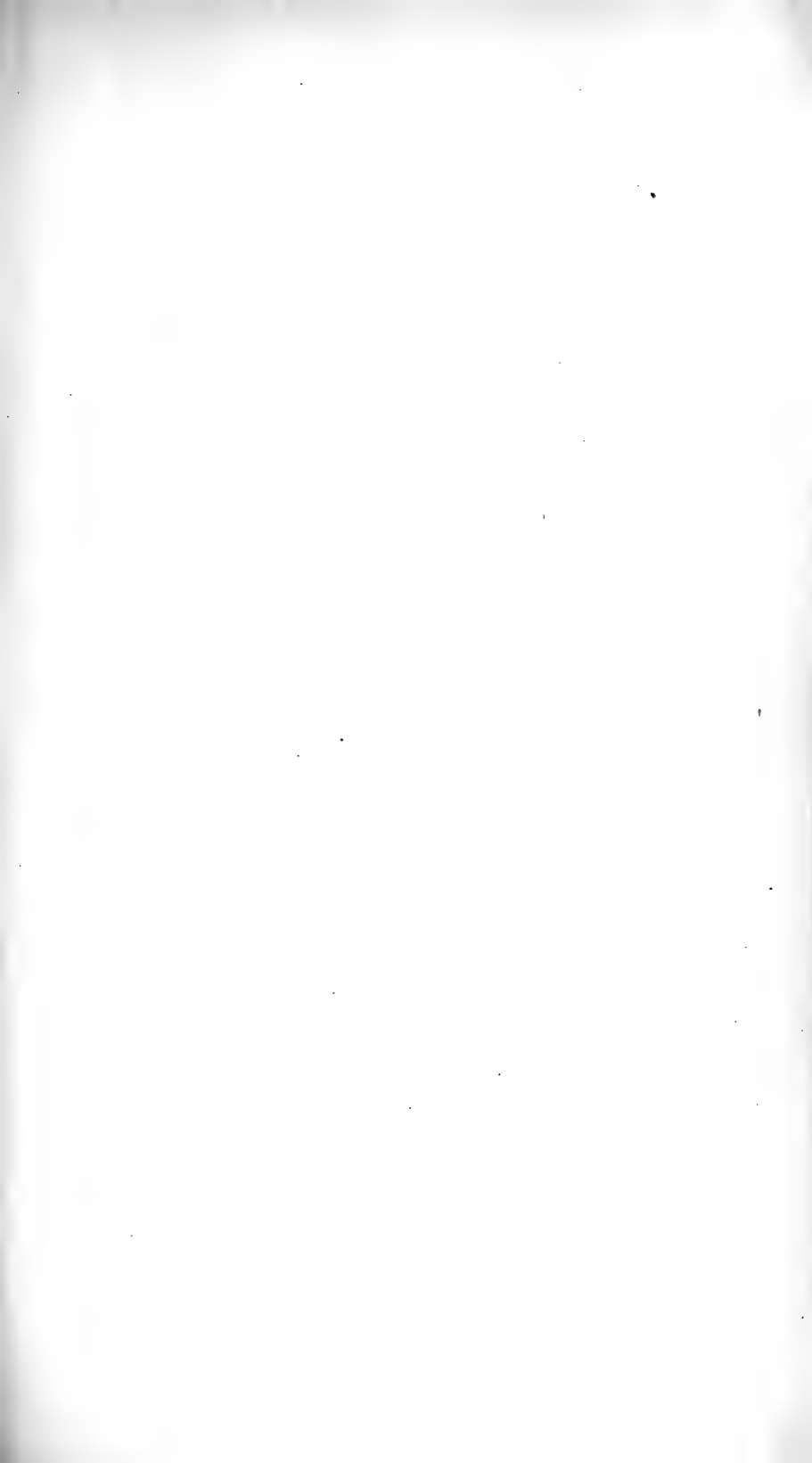
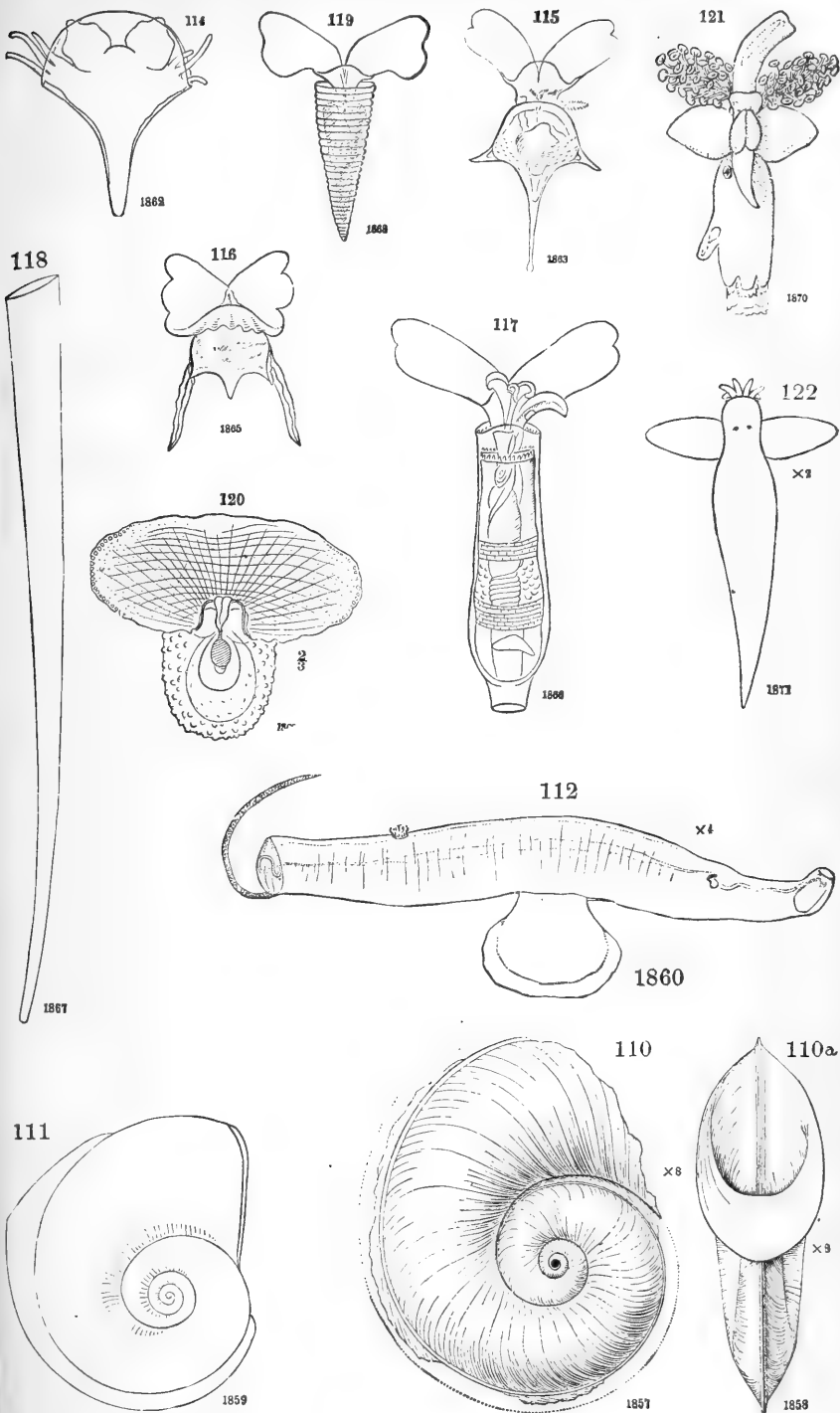
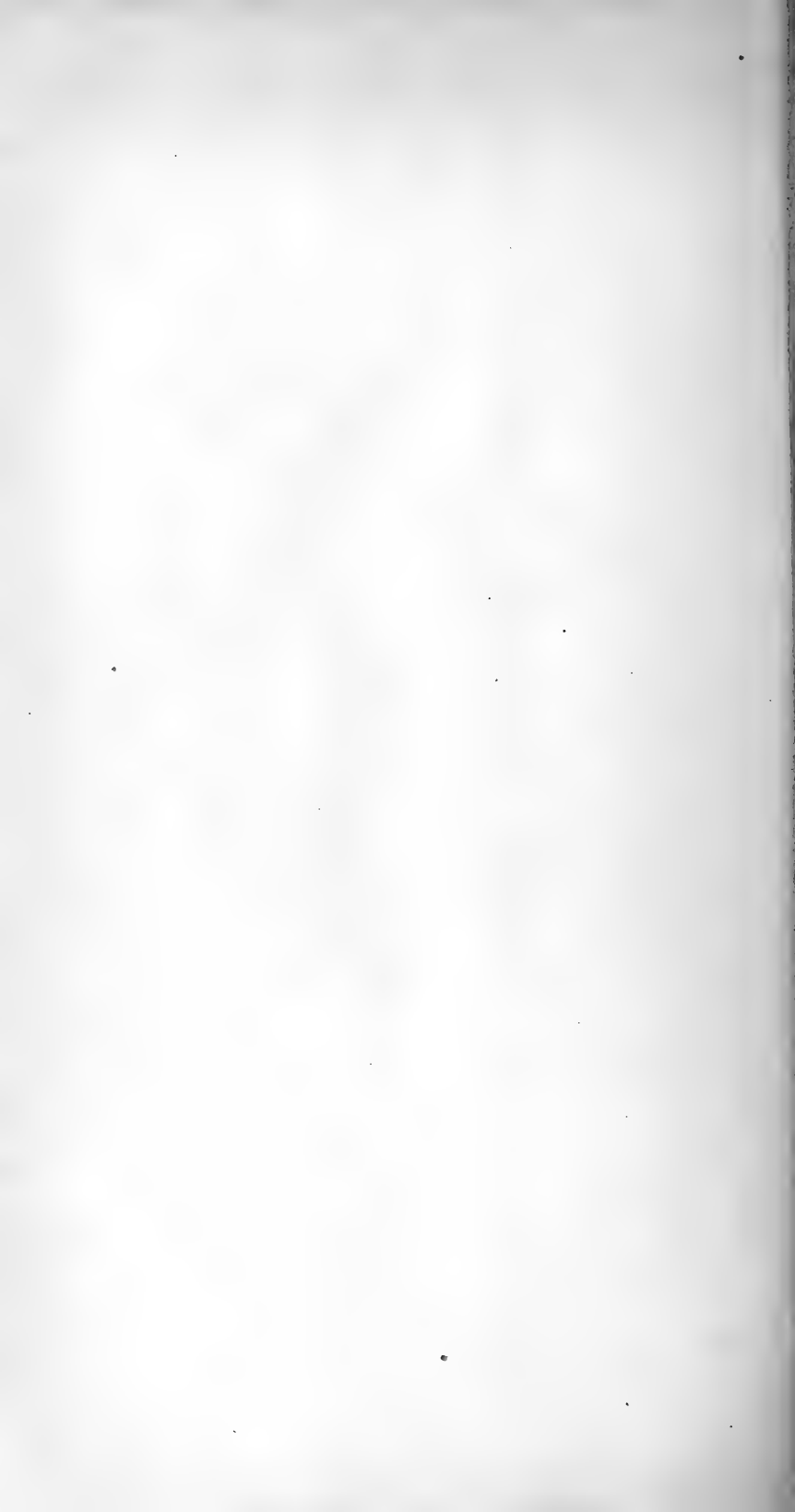


PLATE XXIX.

- FIG. 110. *Atlanta Peronii*. Side view of a somewhat broken specimen, enlarged eight diameters.
- FIG. 110 a. The same specimen. Front view.
- FIG. 111. *Atlanta Gandichaudii*. Side view, much enlarged.
- FIG. 112. *Firola Keraudrenii*. Side view of a specimen preserved a short time in alcohol, enlarged four diameters.
- FIG. 114. *Pleuropus Harger* V. Side view of one of the type specimens, preserved in alcohol.
- FIG. 115. *Diacria trispinosa*. Expanded animal and shell, enlarged about two diameters.
- FIG. 116. *Cavolina uncinata*. Expanded animal and shell, enlarged about two diameters.
- FIG. 117. *Triptera columnella*. Expanded animal and shell, much enlarged.
- FIG. 118. *Styliola recta*. Shell, much enlarged.
- FIG. 119. *Styliola striata*. Expanded animal and shell, much enlarged.
- FIG. 120. *Cymbulia calceolus*. Front view of a specimen a short time in alcohol, two-thirds natural size.
- FIG. 121. *Spongiobranchia australis*. Ventral view of the living animal, much enlarged.
- FIG. 122. *Clione papilionacea*. Dorsal view of the living animal, enlarged two diameters.

Figs. 114, 118, and 122 were drawn by the author; 110, 112, and 120 by J. H. Emerton; 115, 116, 117, 119, and 121 were copied from Eydoux and Souleyet by Ensign W. E. Safford; Fig. 111 is a camera lucida drawing by Mr. Safford.





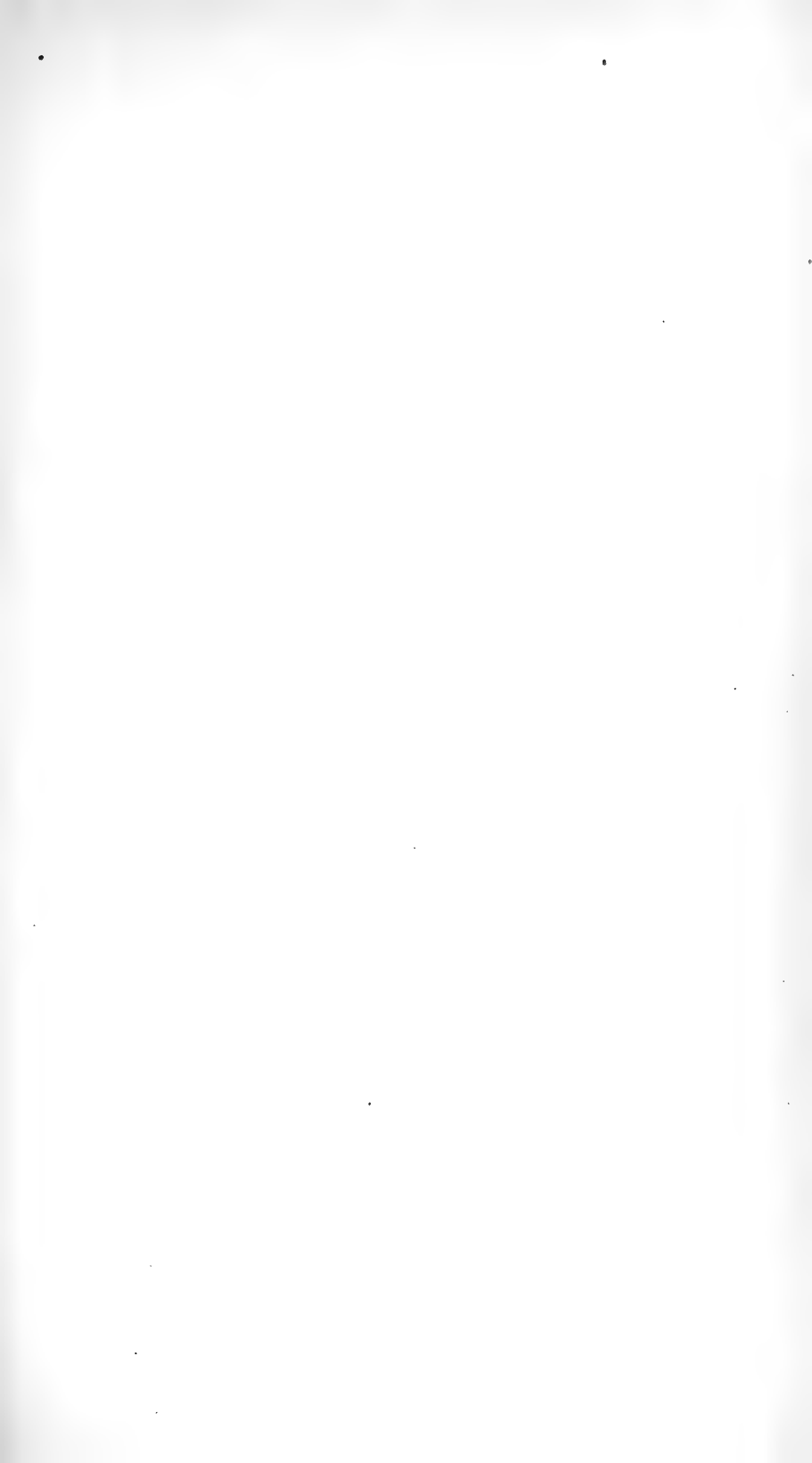
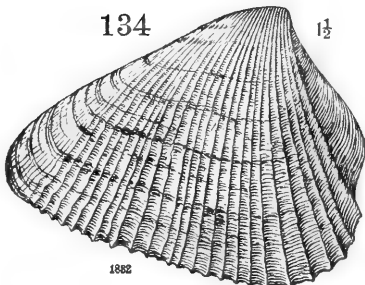
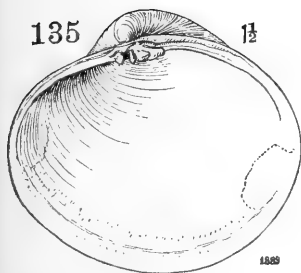
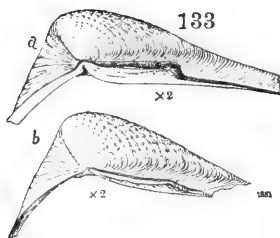
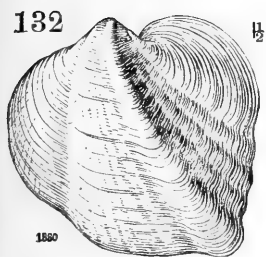
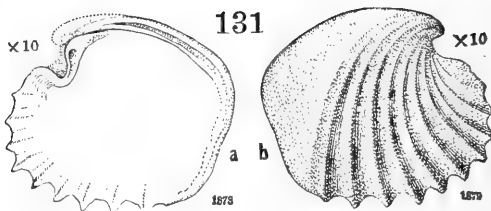
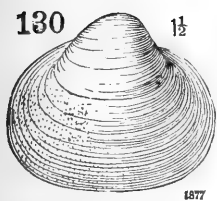
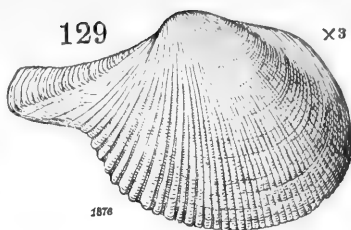
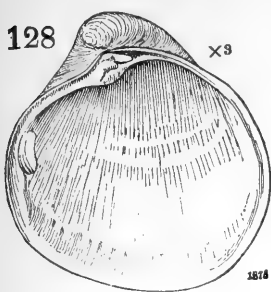


PLATE XXX.

- FIG. 127. *Teredo megotara*. Side view of the animal in expansion, one-half natural size.
- FIG. 128. *Poromya sublevis* V. Inner surface of right valve, enlarged three diameters.
- FIG. 129. *Neara multicostata* V. & S., enlarged three diameters.
- FIG. 130. *Thracia nitida* V. Type specimen, enlarged one and one-half diameters.
- FIG. 131. *Verticordia costata* V. Type specimen, enlarged ten diameters; *a*, interior of the right valve; *b*, exterior of the same valve.
- FIG. 132. *Mytilimeria flexuosa* V. & S. Type specimen, enlarged one and one-half diameters.
- FIG. 133. *Pholadomya arata* V. & S. Portion of right valve of two specimens to show variations in the hinge, enlarged two diameters; *a*, form with more thickened hinge margin; *b*, shorter and more triangular form with thinner hinge margin.
- FIG. 134. The same. Type specimen. Exterior of the right valve, enlarged one and one-half diameters.
- FIG. 135. *Diplodonta turgida* V. & S. Interior view of right valve, enlarged one and one-half diameters.





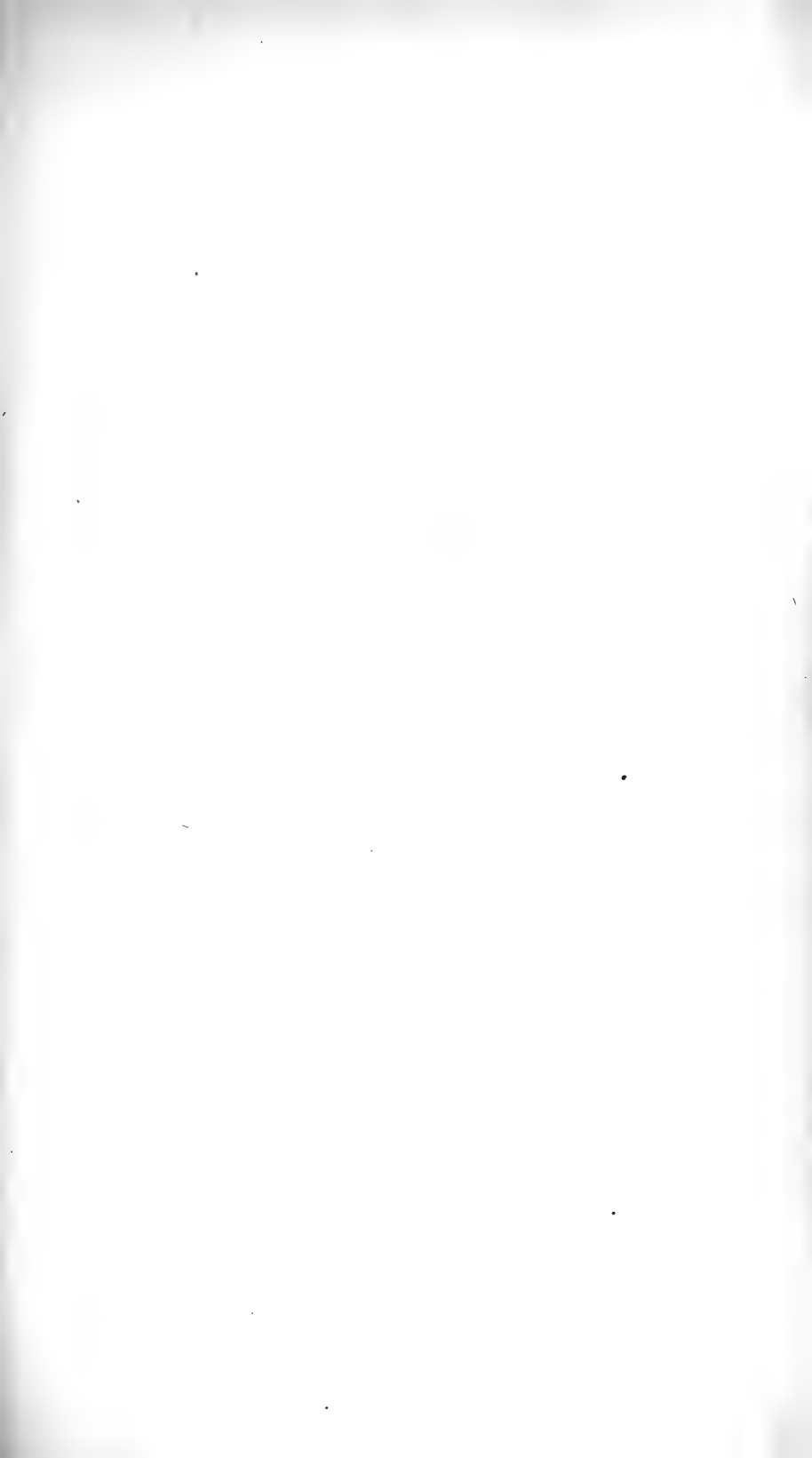
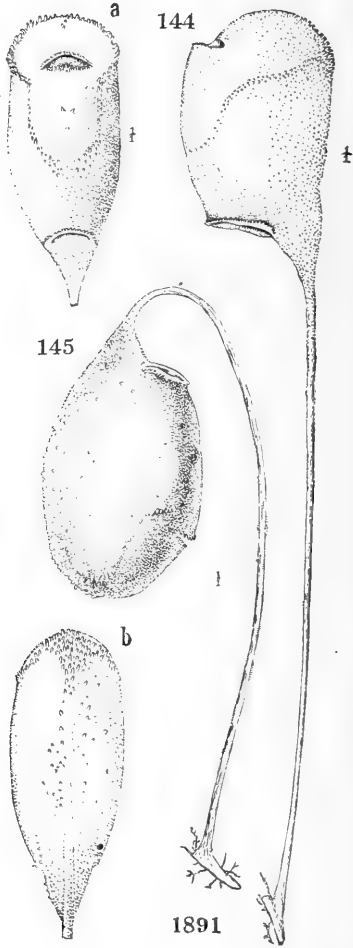
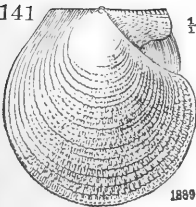
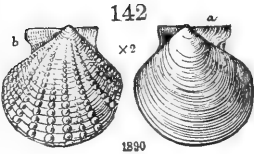
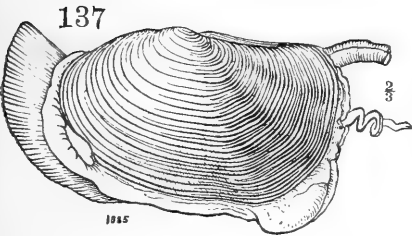
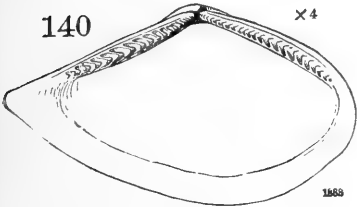
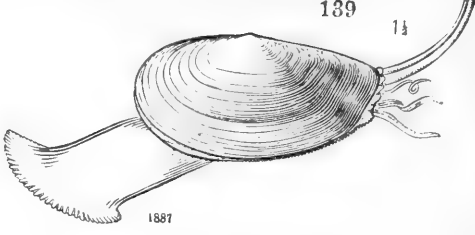
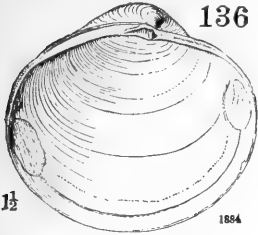


PLATE XXXI.

- FIG. 136. *Diplodonta turgida* V. & S. Interior view of left valve of another specimen, enlarged one and one-half diameters.
- FIG. 137. *Yoldia thraciformis*. Side view of the shell and living animal in expansion, two-thirds natural size.
- FIG. 138. The same. Ventral view of the shell and living animal, two-thirds natural size.
- FIG. 139. *Yoldia sapotilla*. Side view of the shell and living animal in full expansion, one and one-half times natural size.
- FIG. 140. *Leda acuta*. Interior of left valve, enlarged four diameters.
- FIG. 141. *Pecten vitreus*, natural size.
- FIG. 142. *Pecten pustulosus* V. One of the type specimens, enlarged two diameters; *a*, lower valve; *b*, upper valve of the same specimen.
- FIG. 144. *Culeolus Tanneri* V. Side view of one of the type specimens, natural size; *a*, front view of the same specimen.
- FIG. 145. The same. Side view of another type specimen, natural size; *b*, posterior view of the same specimen.
- Figs. 144 and 145 were drawn from specimens preserved a short time in alcohol.



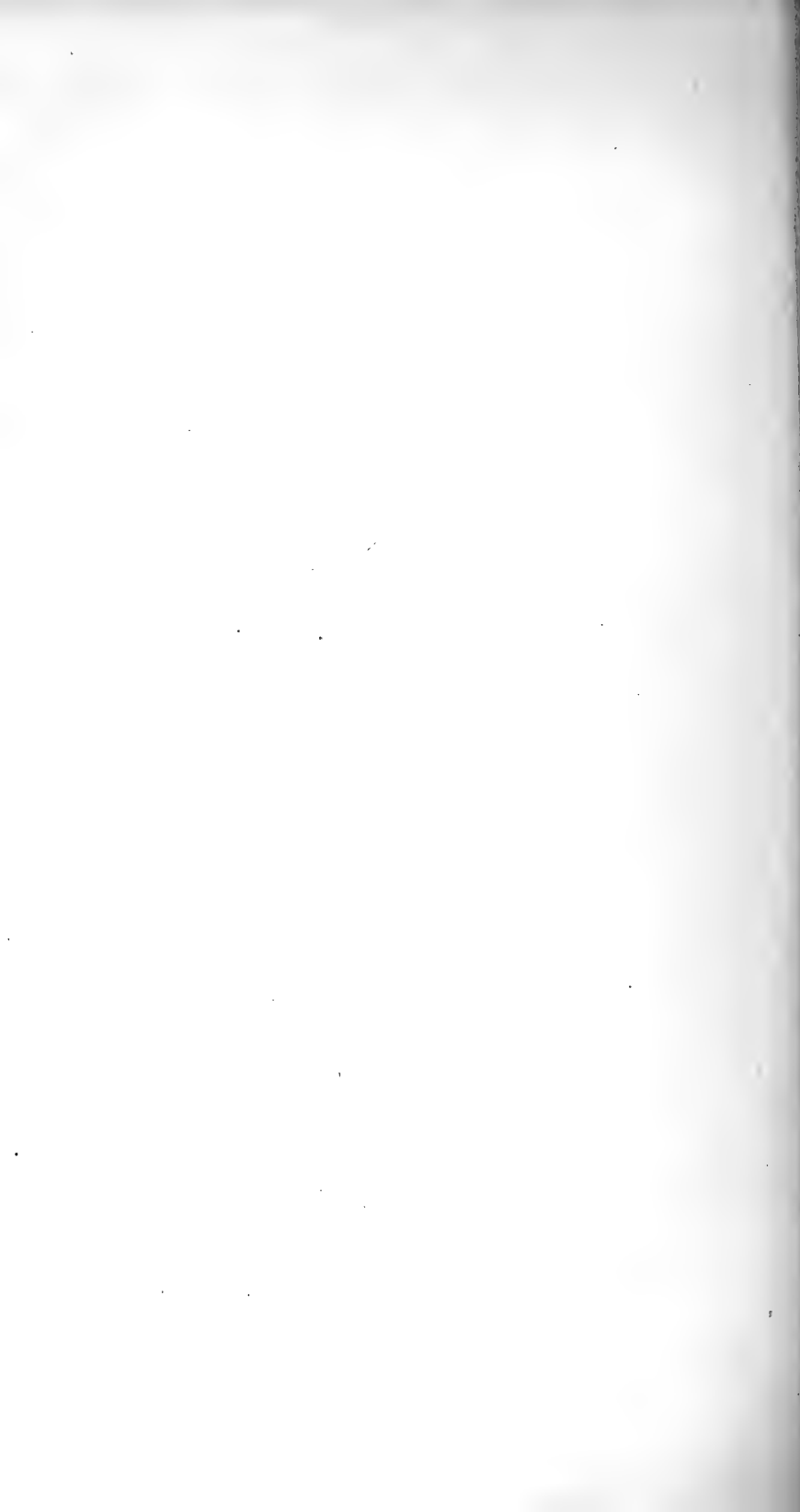


PLATE XXXII.

- FIG. 146. *Doliolum*, sp. View of a small living specimen taken in the Gulf Stream, much enlarged.
- FIG. 147. *Salpa Caboti*. Front view of a living specimen of the solitary form in which a chain is seen in process of development, enlarged three diameters; *a*, side view of the same specimen, which was taken in Vineyard Sound, August, 1884.
- FIG. 148. *Salpa cloths* M.-Edw. Dorsal view of a small individual of the solitary form in which a young chain is seen developing, enlarged three diameters.
- FIG. 149. The same. Side view of a somewhat smaller specimen, enlarged three diameters; *a*, dorsal view of another specimen, natural size.
- FIG. 150. The same species. One of the individuals from a chain not full grown, side view, natural size; *a*, the same specimen, front view.
- Figs. 147-150 were made by J. H. Blake from living specimens taken in Vineyard Sound, August, 1884. Fig. 146 was drawn by J. H. Emerton.

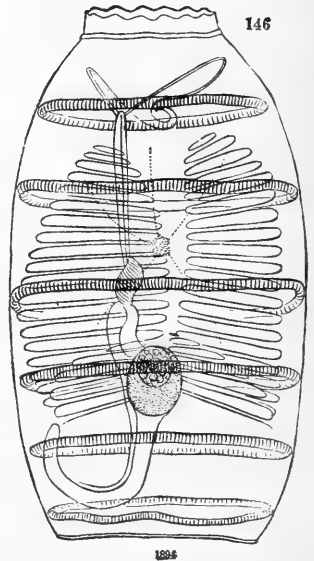
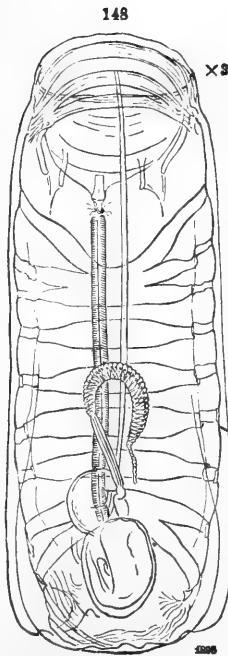
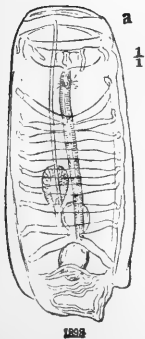
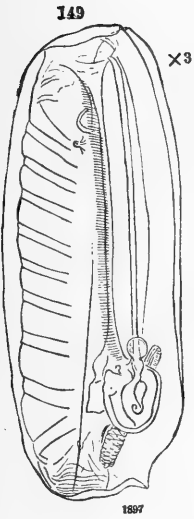
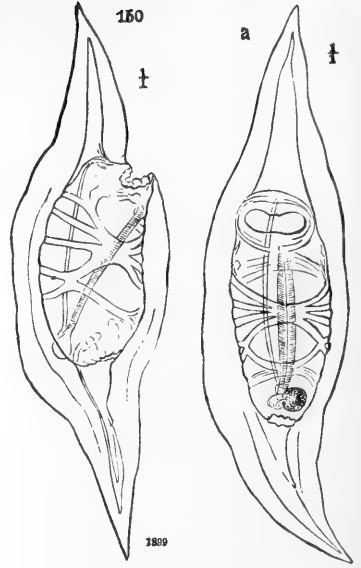
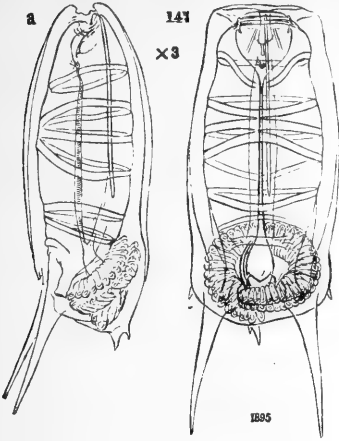
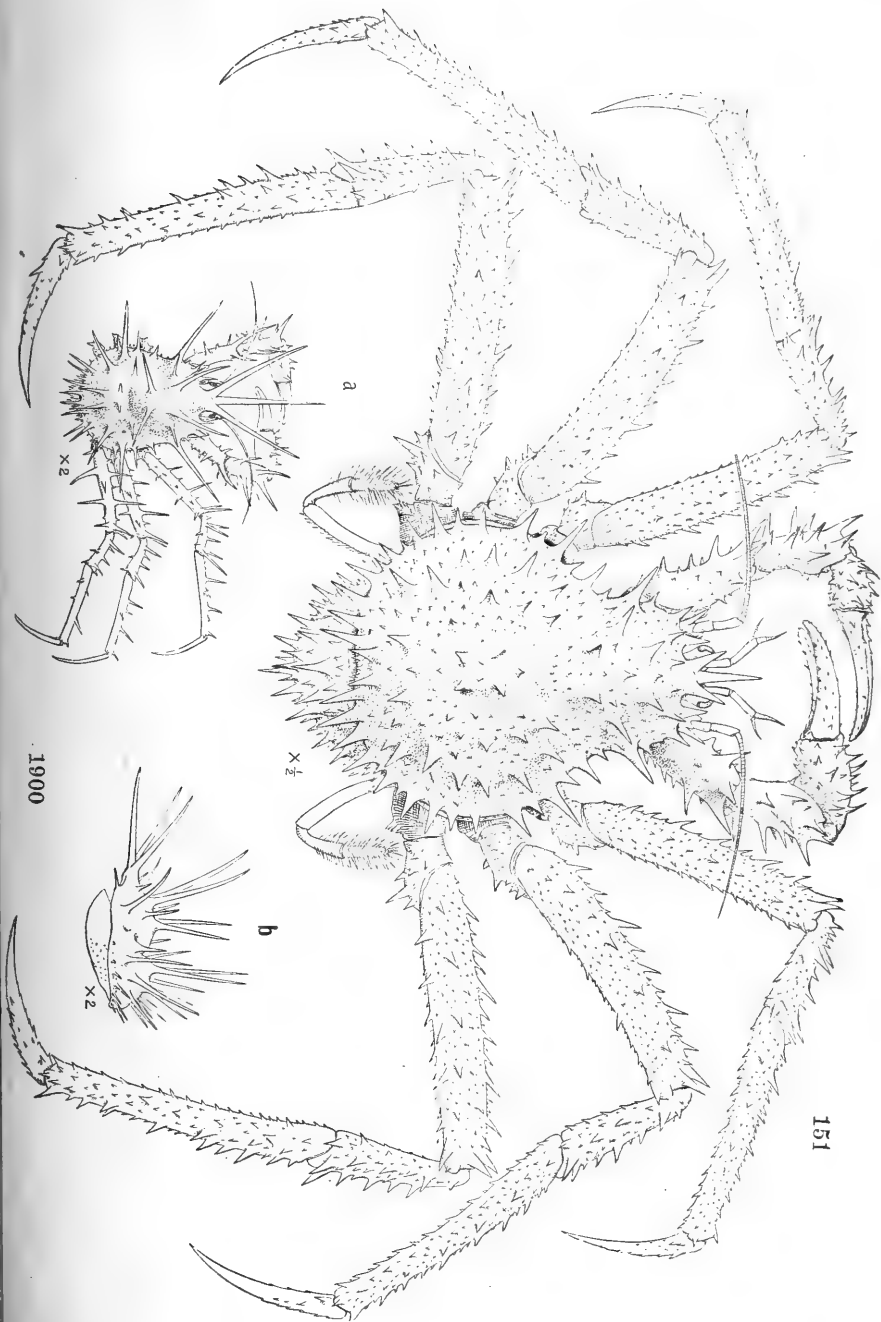


PLATE XXXIII.

FIG. 151. *Lithodes Agassizii* Smith. A small female, one-half natural size; *a*, dorsal view of a young specimen with long spines, enlarged two diameters; *b*, the same specimen, side view of the carapax.



1900

151

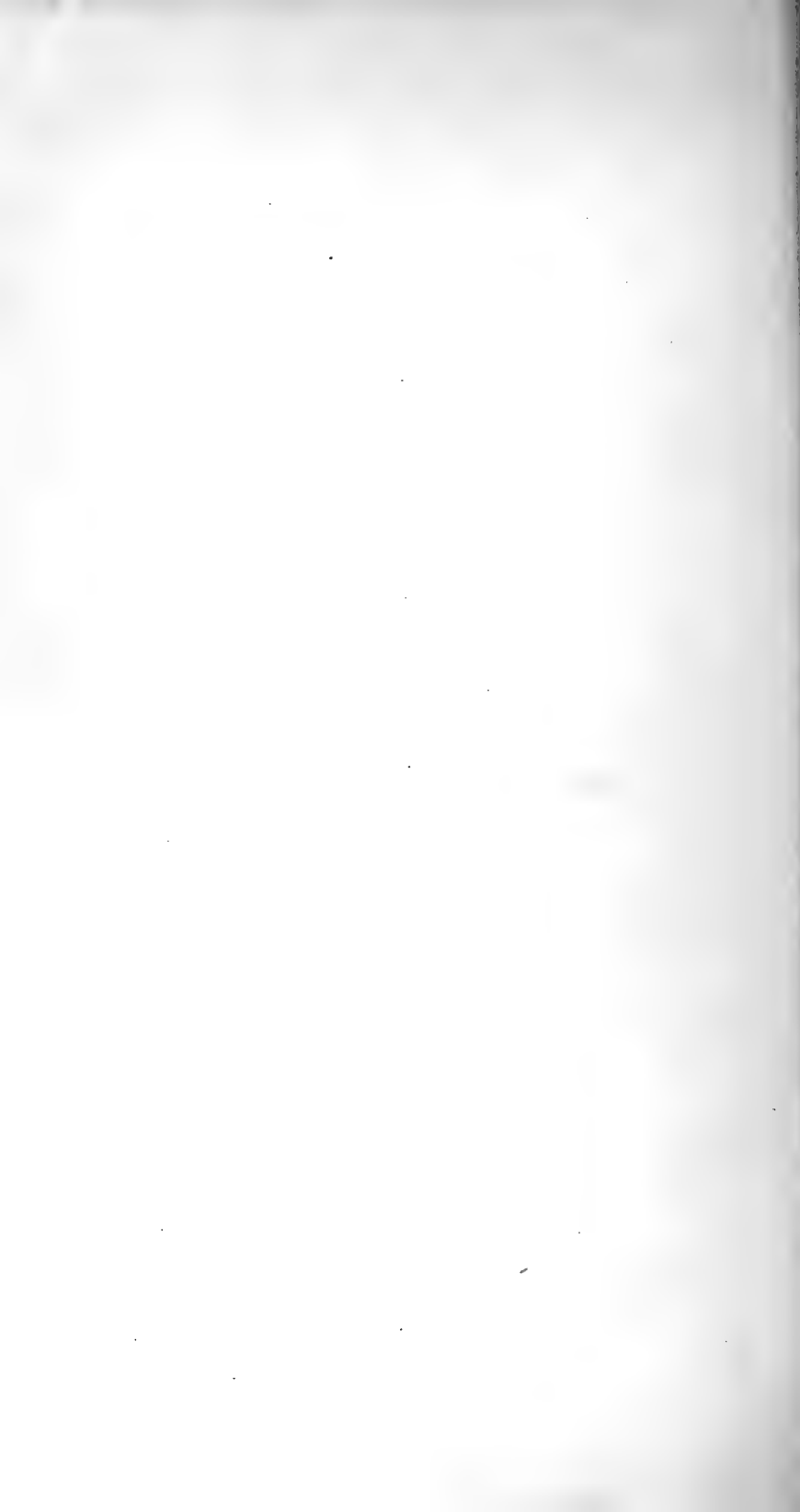
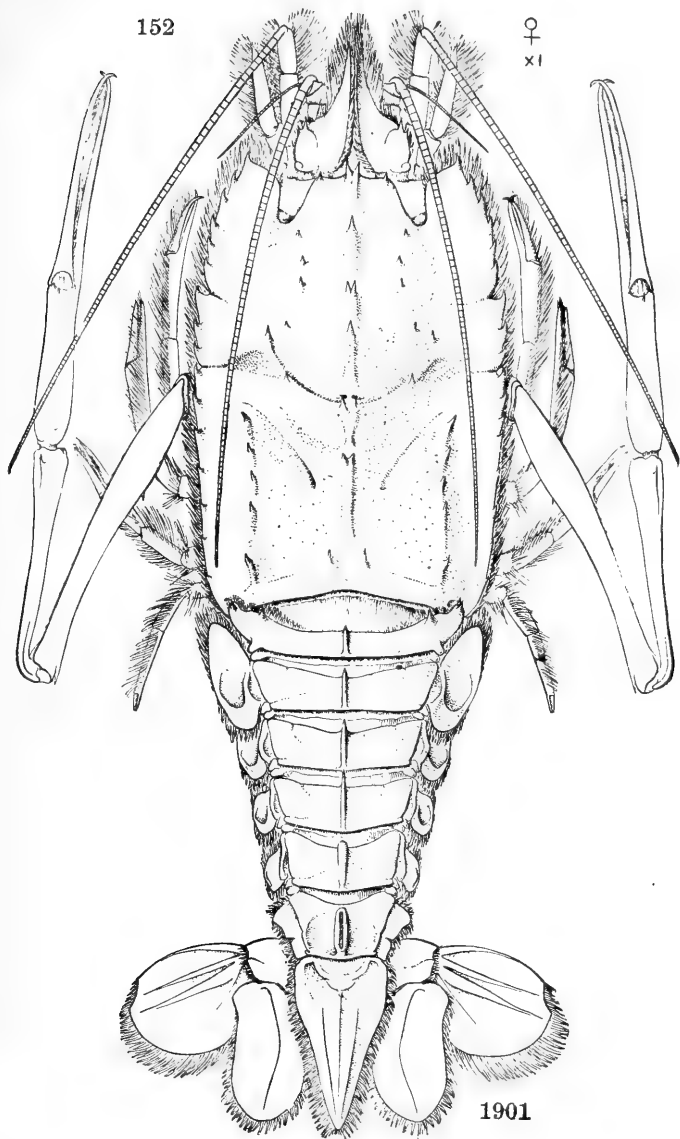
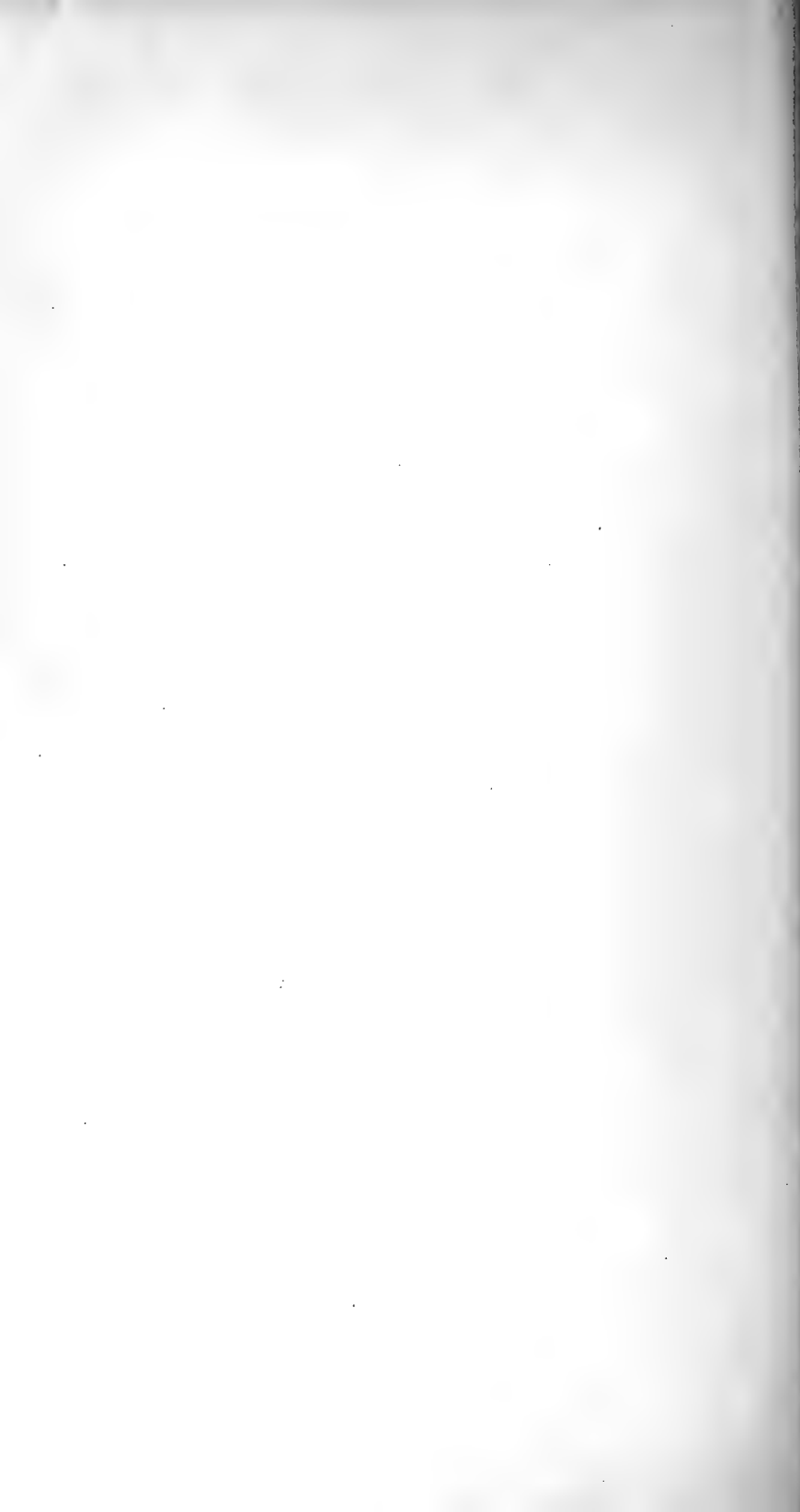


PLATE XXXIV.

FIG. 152. *Pentacheles sculptus* Smith. Female. Dorsal view, natural size.





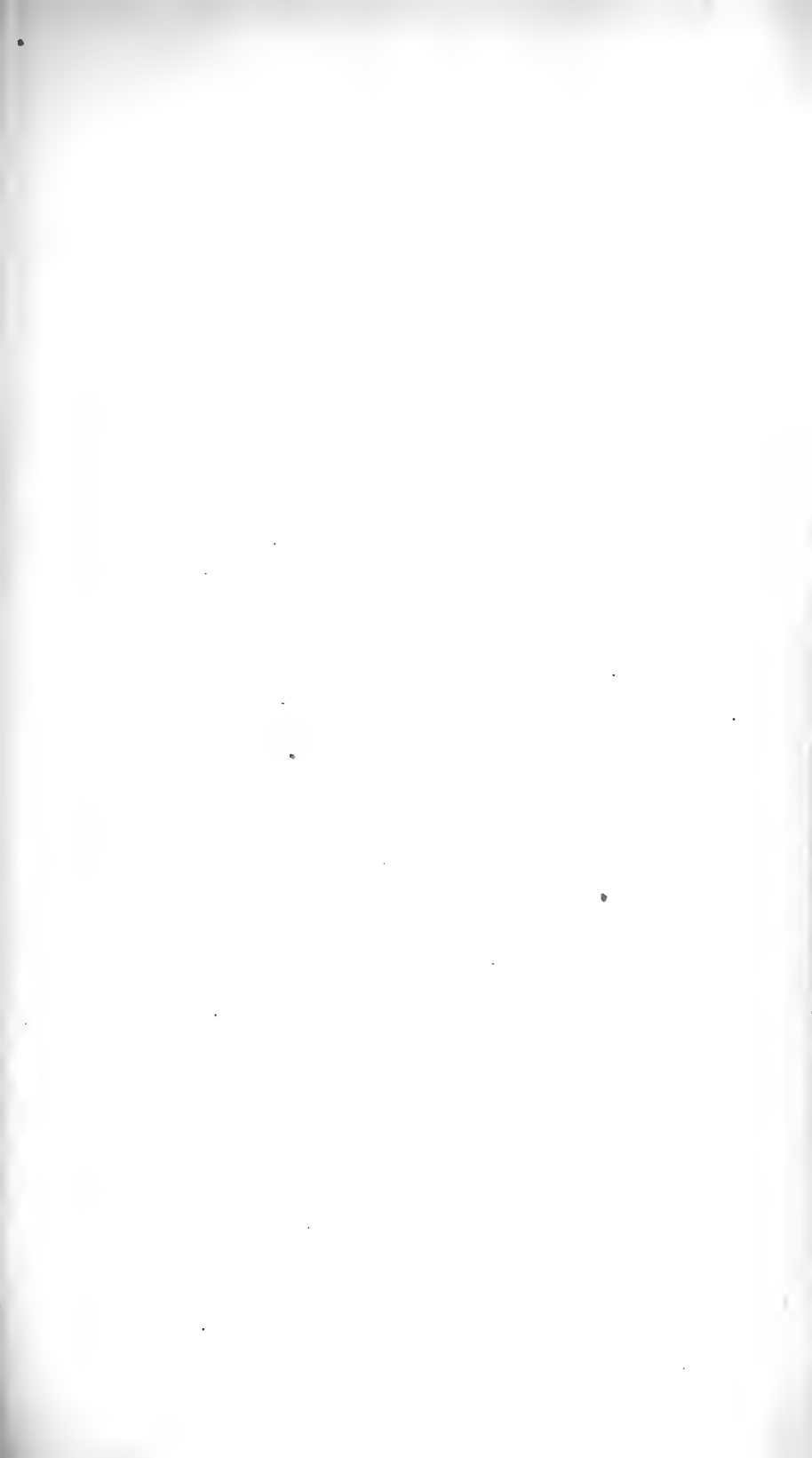
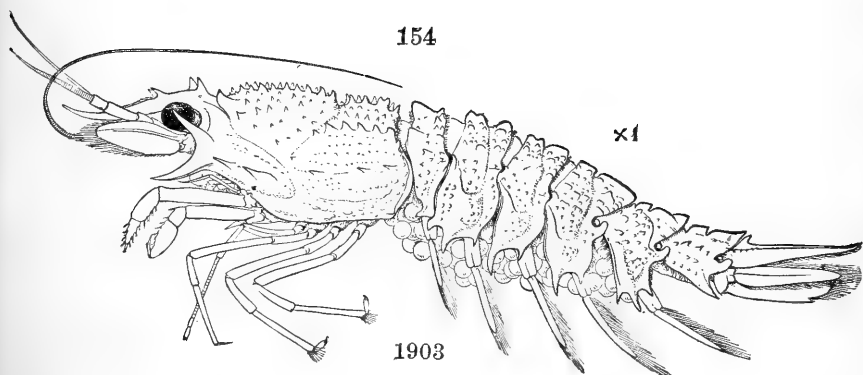
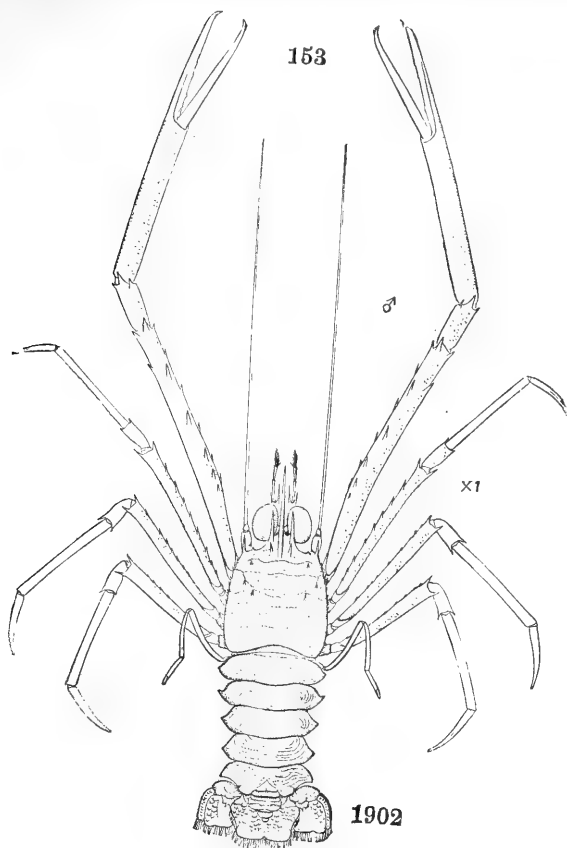


PLATE XXXV.

FIG. 153. *Munida Caribæa* ? Male, natural size.

FIG. 154. *Glyptocrangon sculptus* Smith. Female, natural size.





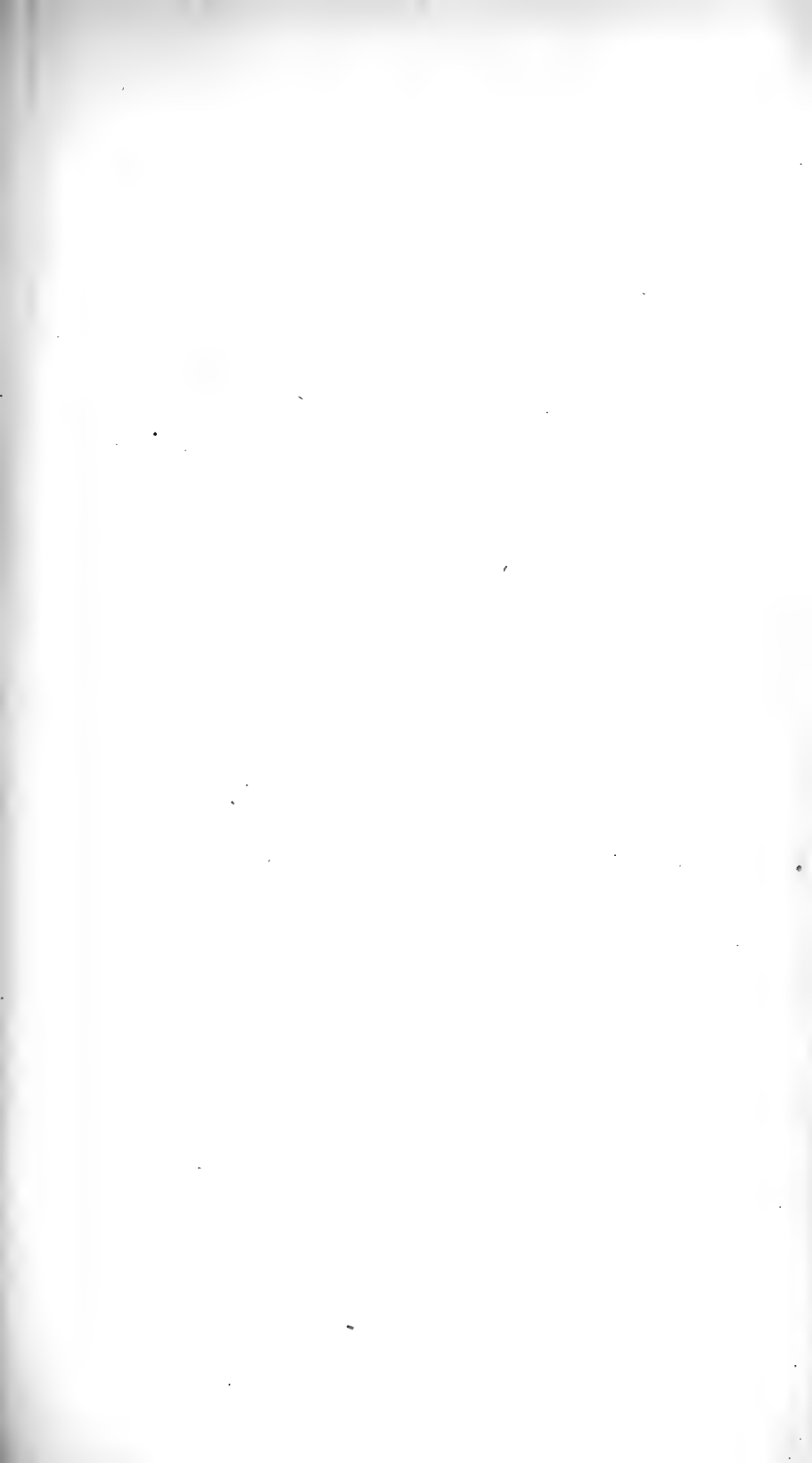
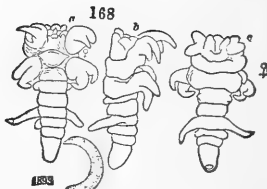
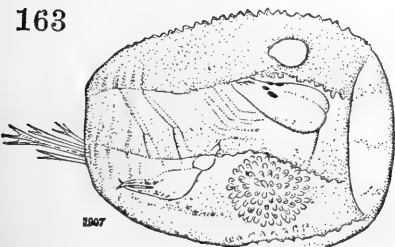
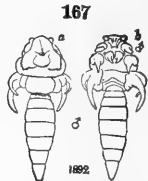
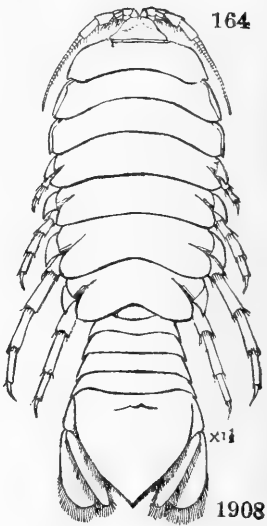
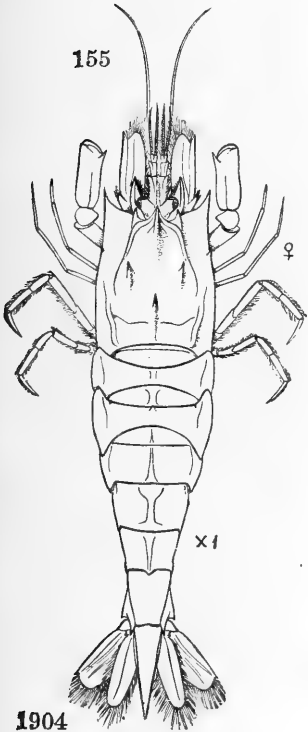
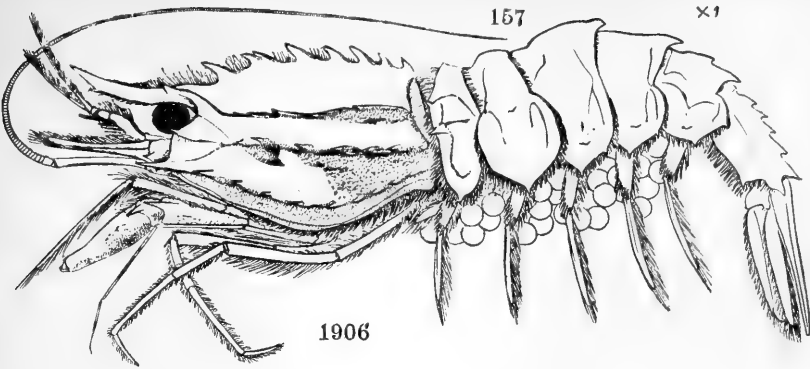
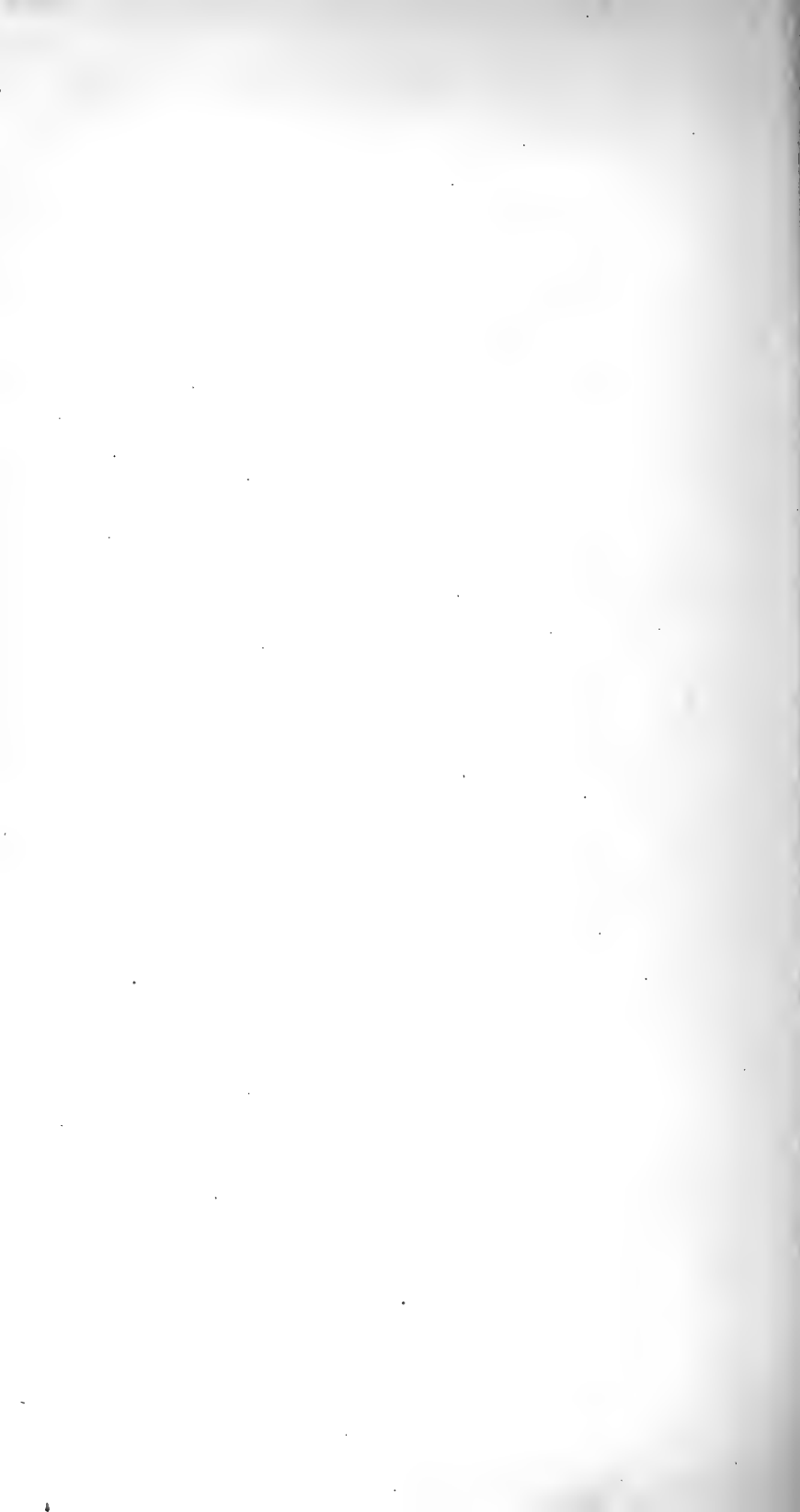


PLATE XXXVI.

- FIG. 155. *Ceraphilus Agassizii* Smith. Female, natural size.
- FIG. 157. *Sabinea princeps* Smith. Female with eggs, natural size.
- FIG. 163. *Phronima*, sp. In a transparent case formed from the test of a large *Salpa*. Female, with young attached to the inner surface of the case, somewhat enlarged.
- FIG. 164. *Sycenus infelix* Harger, enlarged one and one half diameters.
- Fig. 165. *Cirolana impressa* Harger, enlarged three diameters.
- FIG. 167 *Anthecheres Dubenii*. Male, natural size; *a*, dorsal; *b*, ventral view.
- FIG. 168 The same. Female, natural size; *a*, ventral; *b*, lateral; *c*, dorsal view, with a detached egg case.





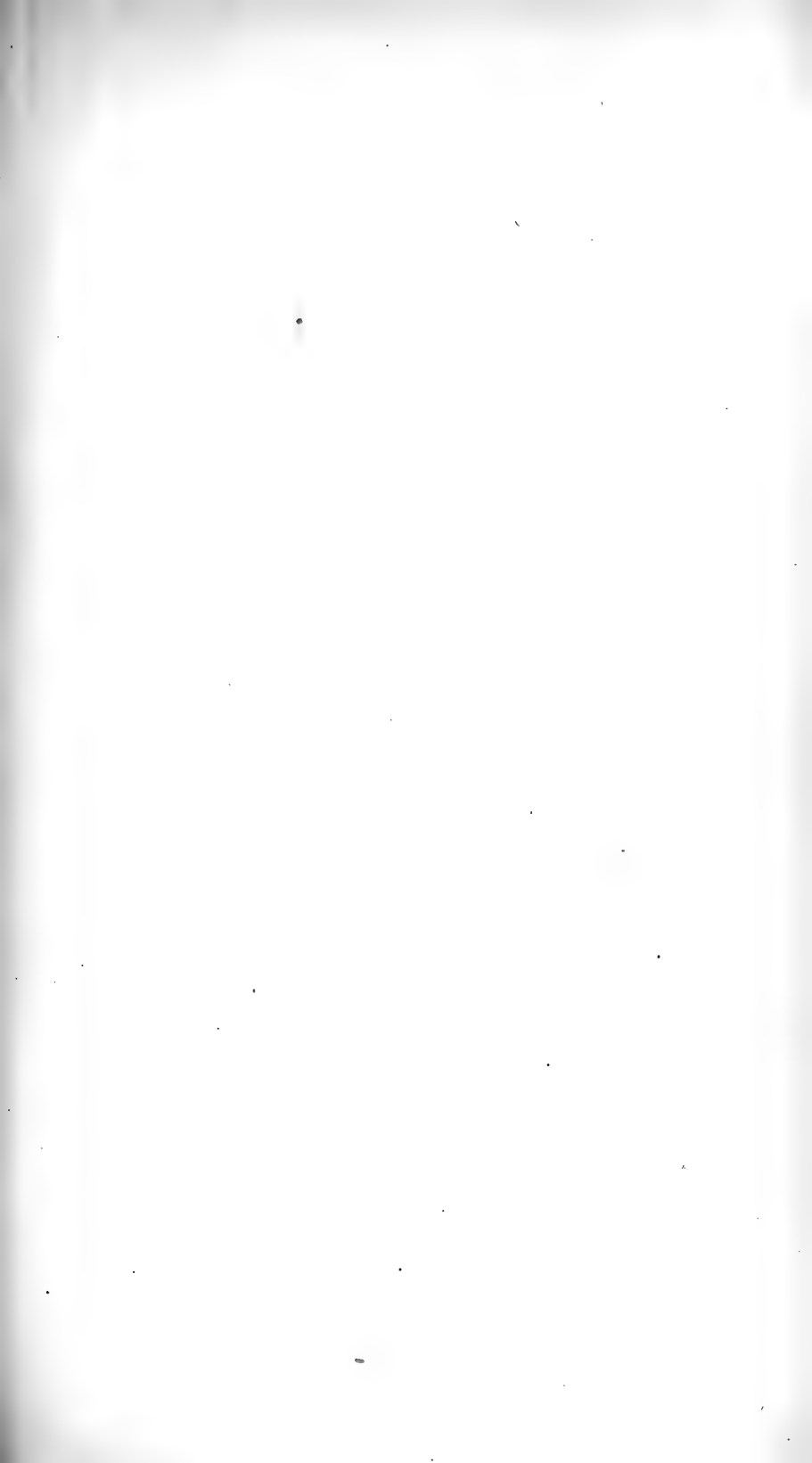
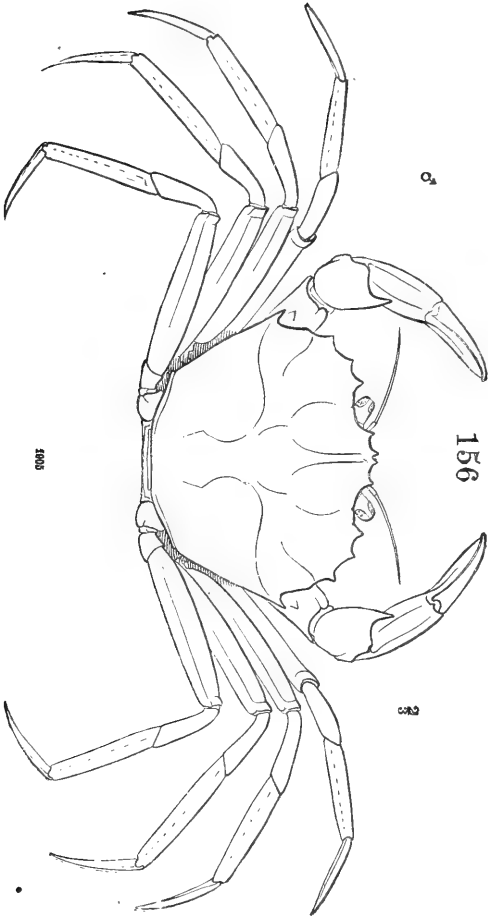


PLATE XXXVII.

FIG. 156. *Geryon quinquedens* Smith. A small male, two-thirds natural size.



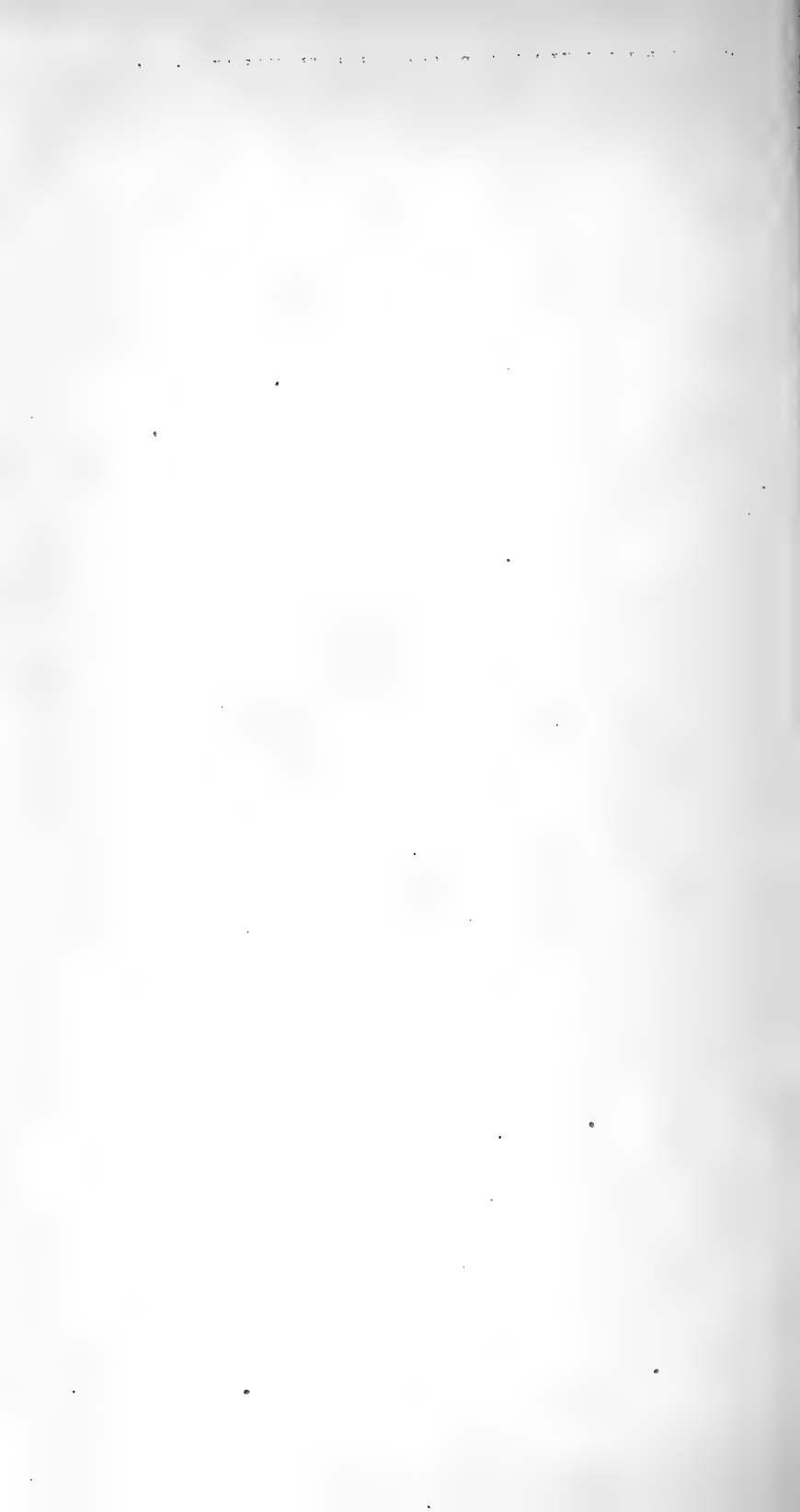




PLATE XXXVIII.

FIG. 169. *Colossendeis collosea*, two-thirds natural size.

FIG. 170. *Colossendeis macerrima*, two-thirds natural size.

FIG. 171. *Scærorhynchus armatus*. Dorsal view, two-thirds natural size; *a*, side view of body, natural size.

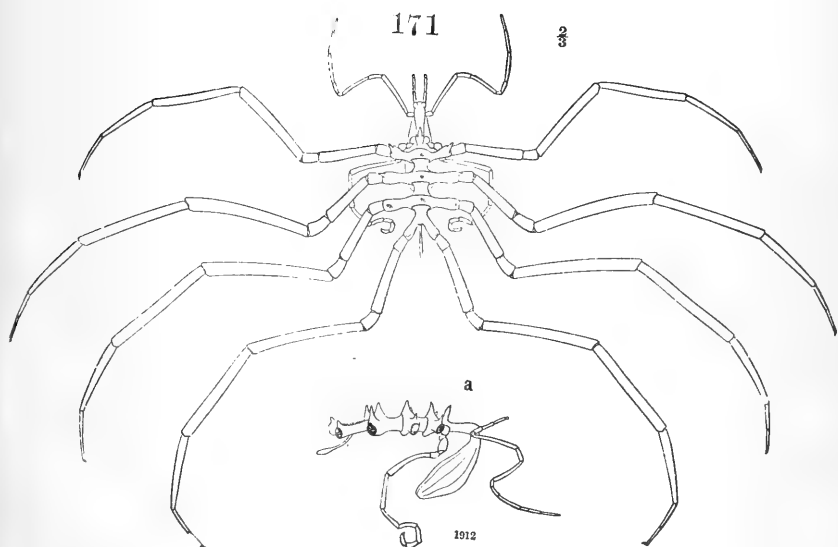
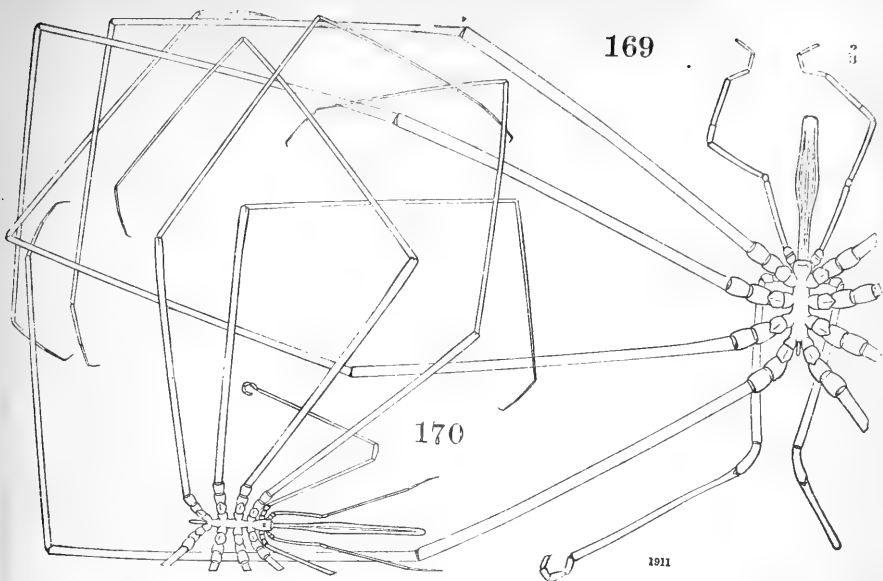






PLATE XXXIX.

- FIG. 172. *Polynoë Acanellæ* V. Dorsal view of the head and anterior segments, enlarged about four diameters.
- FIG. 172 *a*. The same. Part of a scale, enlarged eighty diameters.
- FIG. 172 *b*. The same. One of the parapodia, enlarged twenty diameters; *d*, the argel dorsal setæ; *id*, the slender dorsal setæ; *sv*, large upper setæ of the ventral fascicle; *iv*, smaller and more slender lower setæ of the ventral fascicle; *a*, tips of the dorsal setæ, enlarged eighty diameters; *b*, tip of one of the ventral setæ, enlarged eighty diameters.
- FIG. 172 *c*. The same. Portion of the spinulated part of one of the dorsal setæ to show the character of the spinules and longitudinal furrow, enlarged two hundred and fifty diameters.
- FIG. 176. *Lætmatonice armata* V. Head and anterior segments. Dorsal view, enlarged six diameters. Three anterior scales have been removed to show the head; *a*, median antenna, *c*, *c'*, dorsal cirri of the first pair of parapodia; *p*, tentacular or ventral cirrus of the same parapodia; *vc*, ventral cirrus of the second parapodia; *dc*, dorsal cirrus of the third, and *dc'*, of the sixth parapodia; *ds*, slender dorsal setæ; *ds*, stout dorsal setæ; *vs*, ventral setæ; *h*, head or cephalic lobe; *e*, papilla from which the anterior scale has been removed; *e''* and *e'''*, second and third pairs of scales.
- FIG 176 *a*. The same. Setæ enlarged fifteen diameters; *d* and *d'*, the tips of the stout spine-like dorsal setæ; *ds*, a group of ventral setæ; *vc*, ventral cirrus.

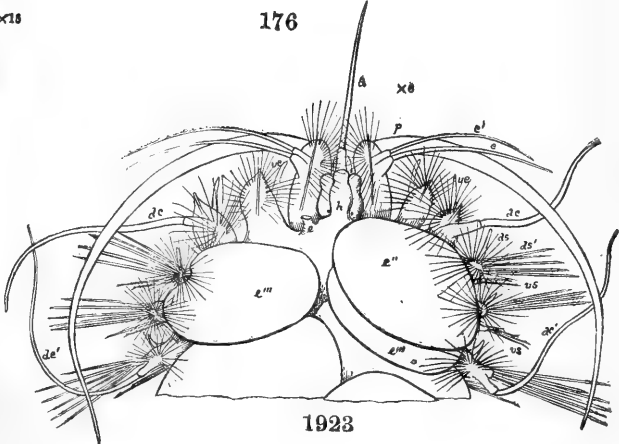
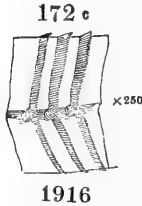
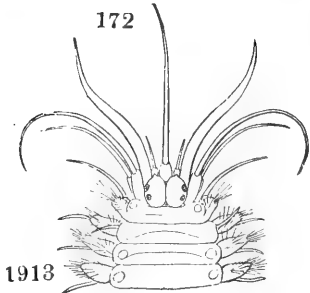
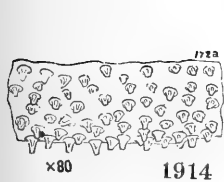
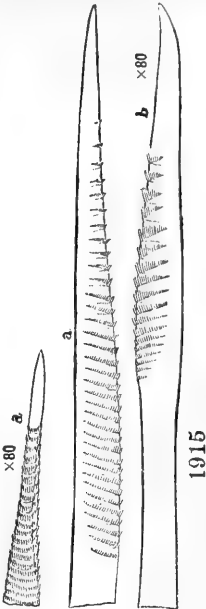
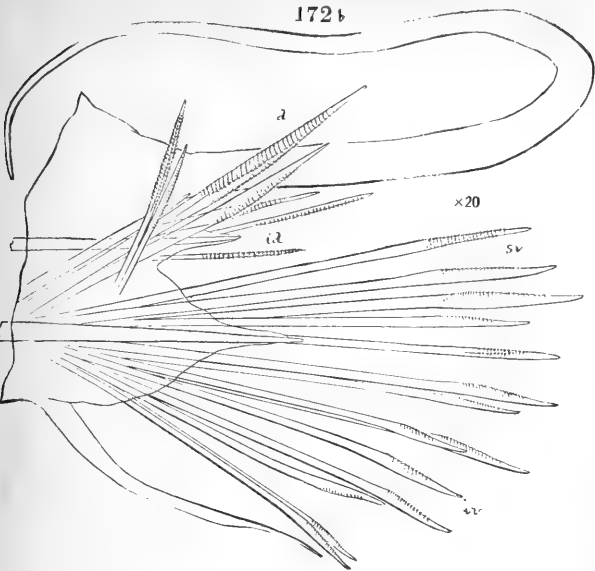
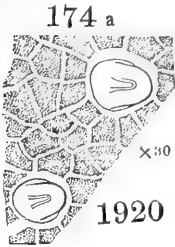
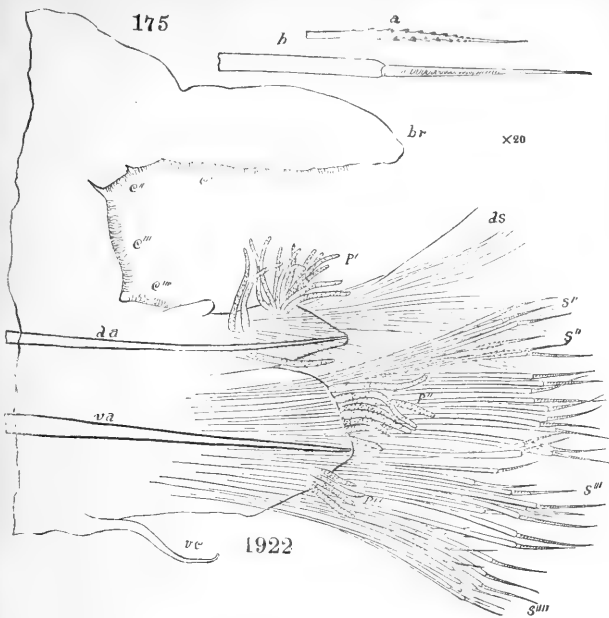


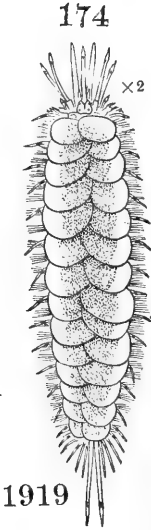
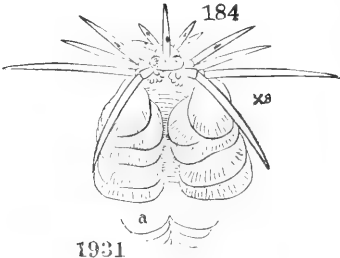
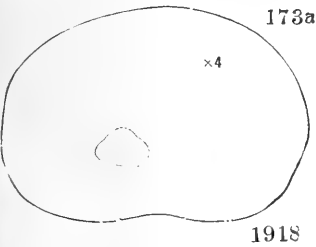


PLATE XL.

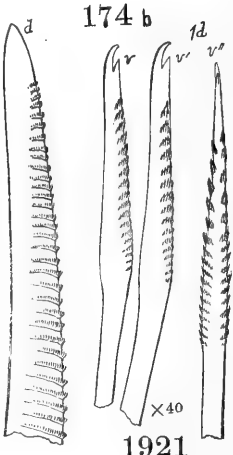
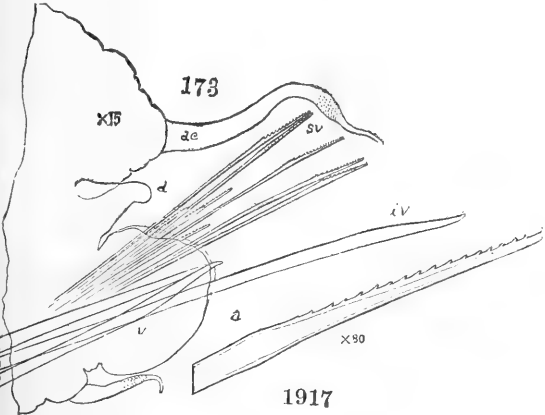
- FIG. 173. *Polynoë aurantiaca* V. One of the parapodia, enlarged fifteen diameters; *dc*, dorsal cirrus; *d*, small dorsal lobe, which is destitute of setæ; *v*, ventral lobe; *sv*, superior ventral setæ; *iv*, large inferior ventral setæ; *a*, one of the superior ventral setæ, enlarged eighty diameters.
- FIG. 173 *a*. The same. One of the scales, enlarged four diameters.
- FIG. 174. *Polynoë (Harmothoë) imbricata*. Dorsal view, enlarged two diameters.
- FIG. 174 *a*. The same. Part of a scale, enlarged thirty diameters.
- FIG. 174 *b*. The same. Setæ, enlarged forty diameters; *d*, one of the stout dorsal setæ; *v*, *v'*, ventral setæ.
- FIG. 175. *Leanira robusta* V. One of the parapodia, enlarged twenty diameters; *br*, branchial lobe of the dorsal side; *e'*, *e''*, *e'''*, line of cilia occupying the space between the branchial and setigerous lobes; *p'*, slender papillæ of the dorsal branch; *p''*, *p'''*, similar appendages of the ventral branch; *vc*, ventral cirrus; *da*, aciculum of the dorsal branch; *va*, aciculum of the ventral branch; *ds*, dorsal setæ; *s'*, *s''*, *s'''*, *s''''*, various forms of setæ of the ventral branch; *a*, tip of one of the slender simple setæ; *b*, tip of one of the compound ventral setæ, much more enlarged.
- FIG. 184. *Notophyllum Americanum* V. Head and anterior segments, enlarged eight diameters; *a*, posterior end of the same specimen.



1920



1919



1921

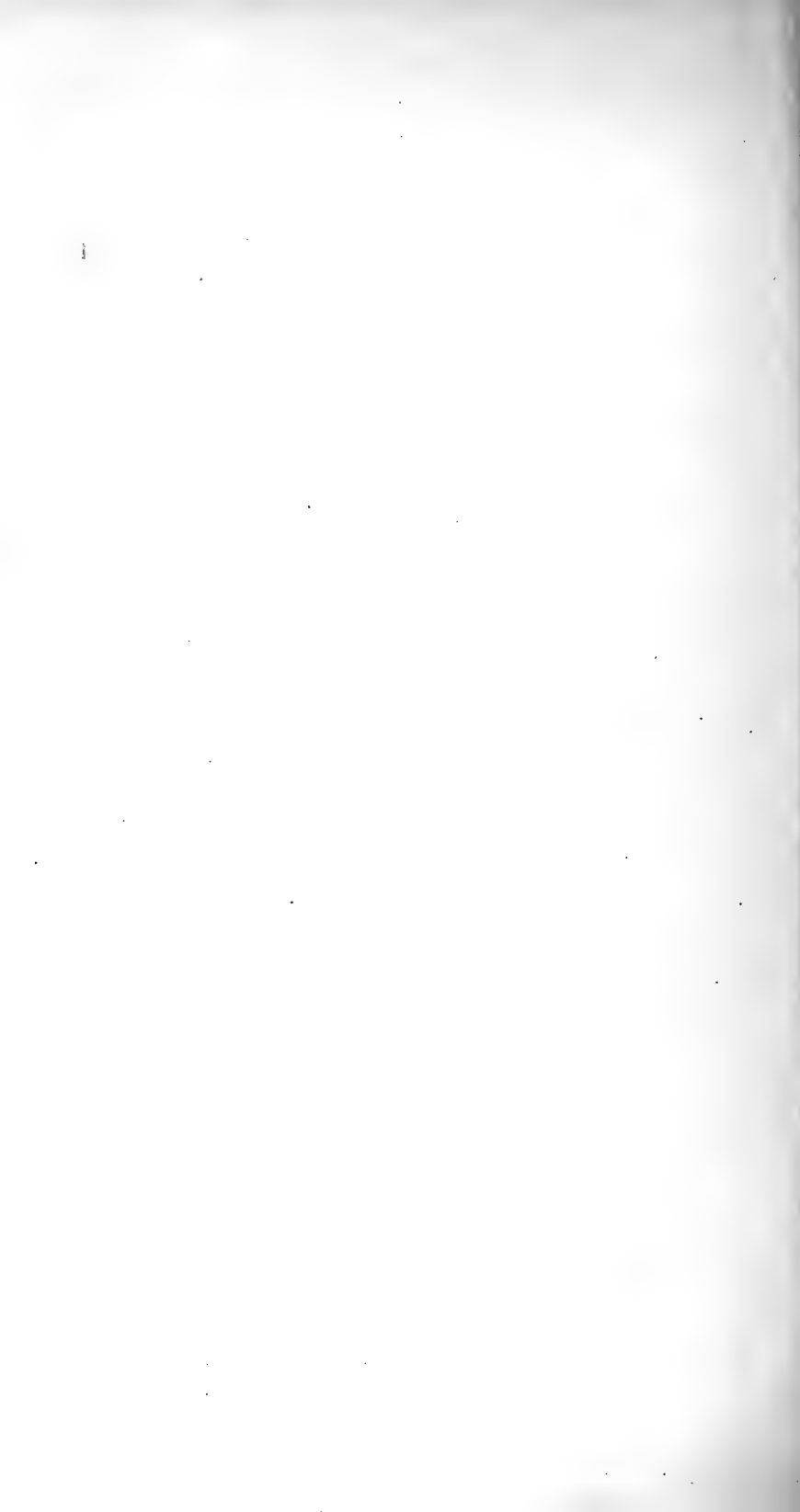
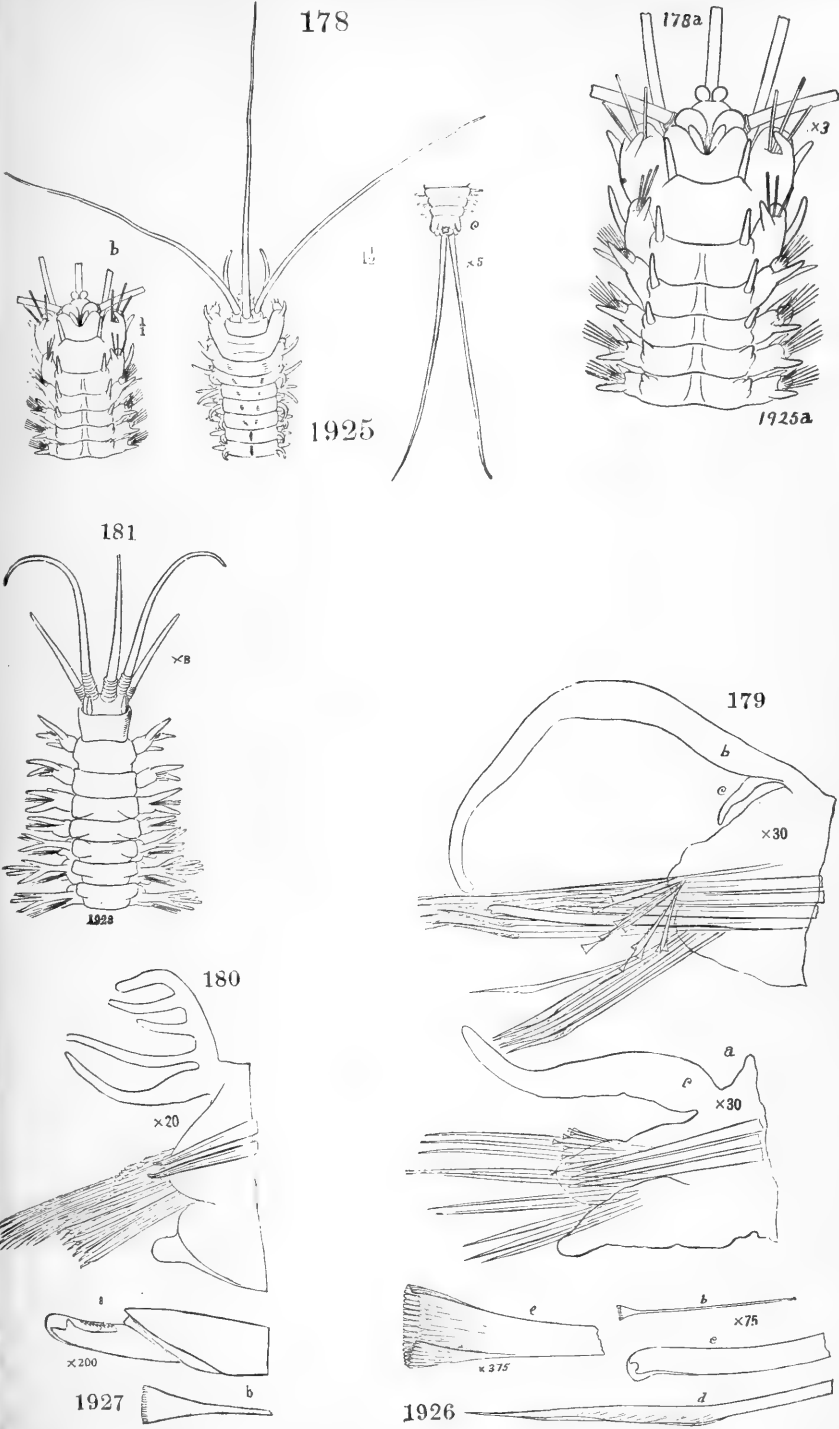


PLATE XLI.

- FIG. 178. *Hyalinæcia artifex* V. Head and anterior segments, enlarged about one and one-half diameters; *b*, the same, ventral view of the head and anterior segments of another specimen, enlarged about one and one-half diameters; *c*, the same, posterior segments and caudal cirri, enlarged five diameters.
- FIG. 178 *a*. The same. Ventral view of the head and anterior segments, enlarged three diameters.
- FIG. 179. The same. One of the anterior parapodia, enlarged thirty diameters; *b*, branchia; *c*, dorsal cirrus; *a*, one of the parapodia from a segment farther back, destitute of the branchia, enlarged thirty diameters; *c*, dorsal cirrus; *b*, one of the funnel-shaped setæ, enlarged seventy-five diameters; *e*, the same, enlarged three hundred and seventy-five diameters; *c*, a seta with bilobed tip, enlarged seventy-five diameters; *d*, spiniform seta, enlarged seventy-five diameters.
- FIG. 180. *Leodice polybranchia* V. One of the parapodia, enlarged twenty diameters; *a*, tip of one of the compound setæ, enlarged one hundred diameters; *b*, tip of one of the funnel-shaped setæ, enlarged two hundred diameters.
- FIG. 181. *Nothria conchyphila* V. Dorsal view of head and anterior segments, enlarged eight diameters.



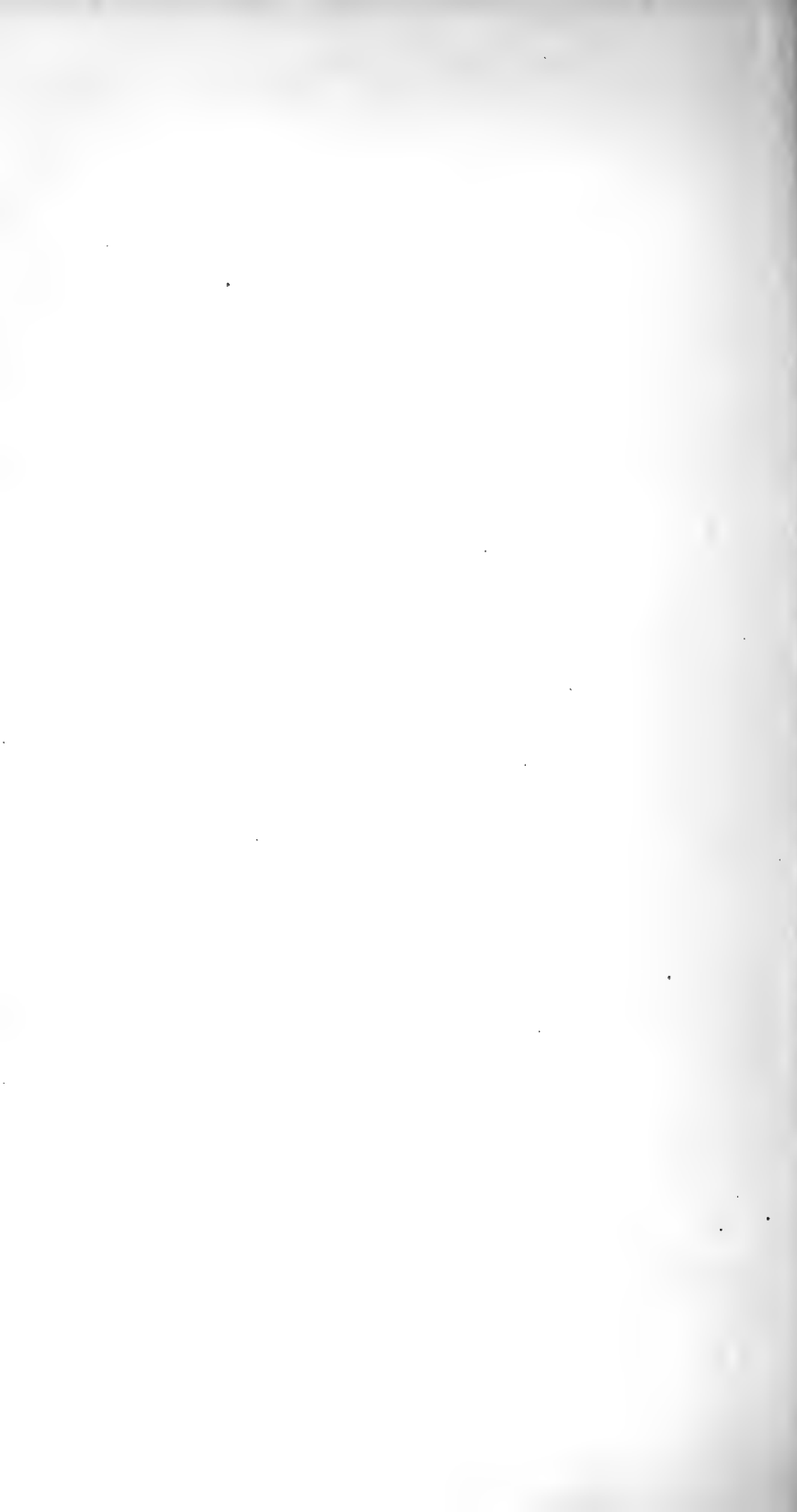
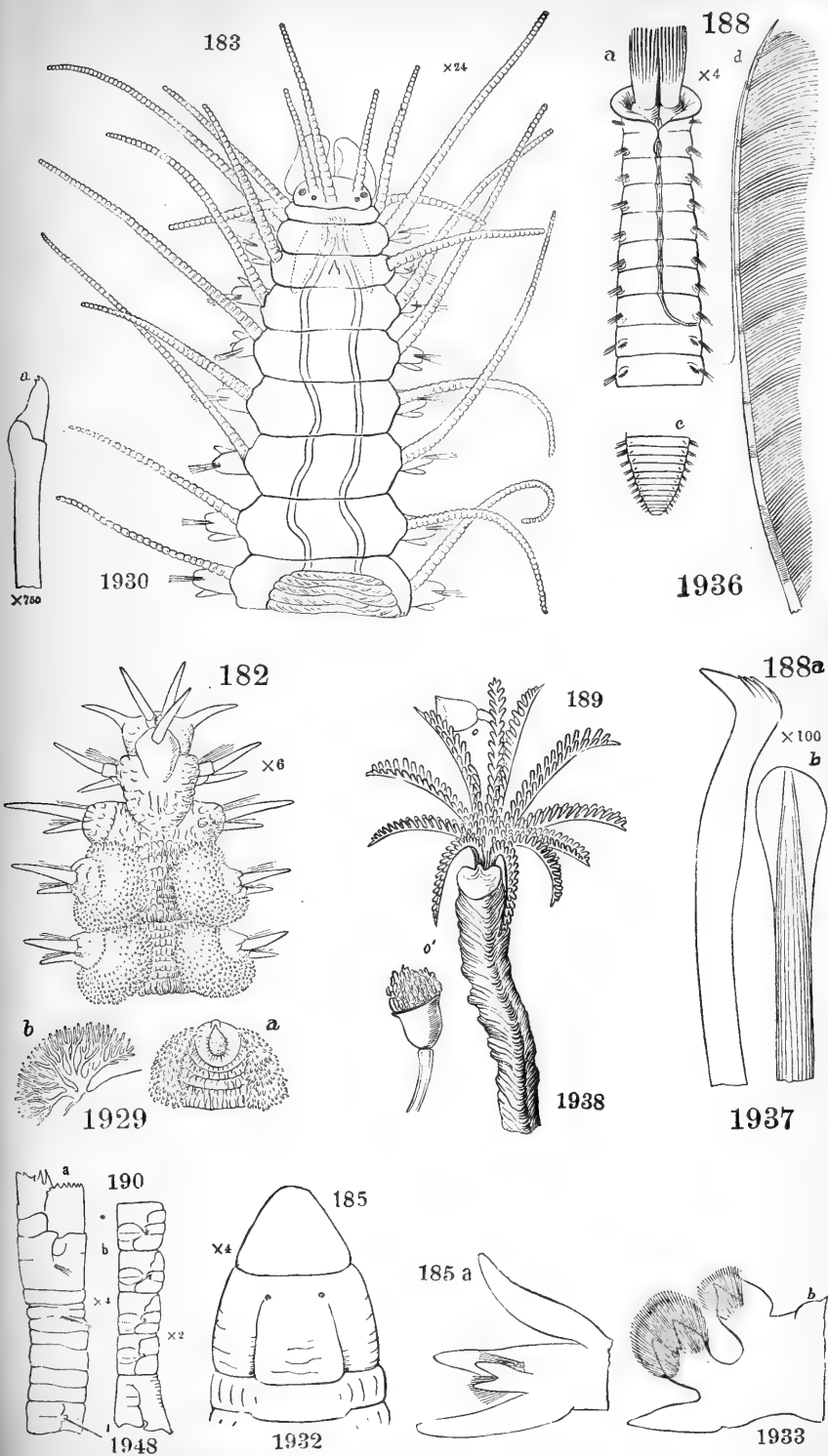
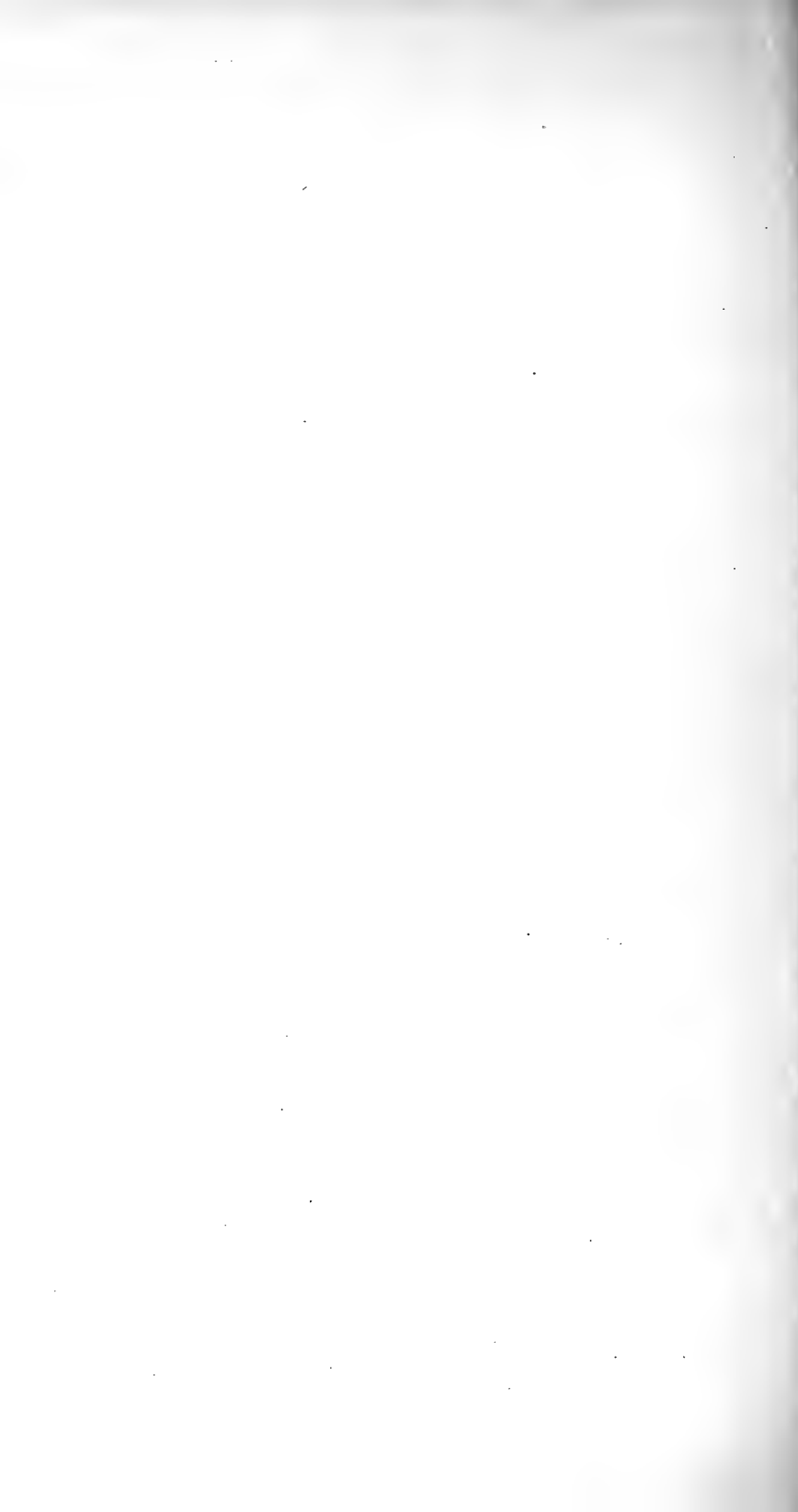


PLATE XLII.

- FIG. 182. *Amphinome Lepadis* V. Head and anterior segments, enlarged six diameters; *a*, posterior extremity of the same specimen; *b*, one of the branchiæ. This specimen was found among stems of *Lepas*, on floating timber, in the Gulf Stream.
- FIG. 183. *Syllis spongiphila* V. Dorsal view of the head and anterior segments, enlarged twenty-four diameters; *a*, one of the compound setæ, enlarged seven hundred and fifty diameters.
- FIG. 185. *Ophioglycera grandis* V. Head, enlarged four diameters.
- FIG. 185 *a*. The same. One of the parapodia from the anterior region; *b*, one of the parapodia from the middle region of the body. From a specimen taken at the surface in Newport Harbor.
- FIG. 188. *Sabella picta* V. Anterior segments and base of branchiæ, ventral view, enlarged four diameters; *c*, the same, posterior segments; *d*, one of the branchiæ.
- FIG. 188 *a*. The same. One of the hook-shaped setæ, enlarged one hundred diameters; *b*, one of the spatulate setæ, enlarged one hundred diameters.
- FIG. 189. *Vermilia serrula*. Dorsal view of the tube and expanded branchiæ; *o*, side view of operculum; *o*, operculum of another specimen, with adherent dirt.
- FIG. 190. *Maldane biceps*. *a*, anterior portion, side view, enlarged four diameters; *b*, posterior portion, side view, enlarged two diameters.





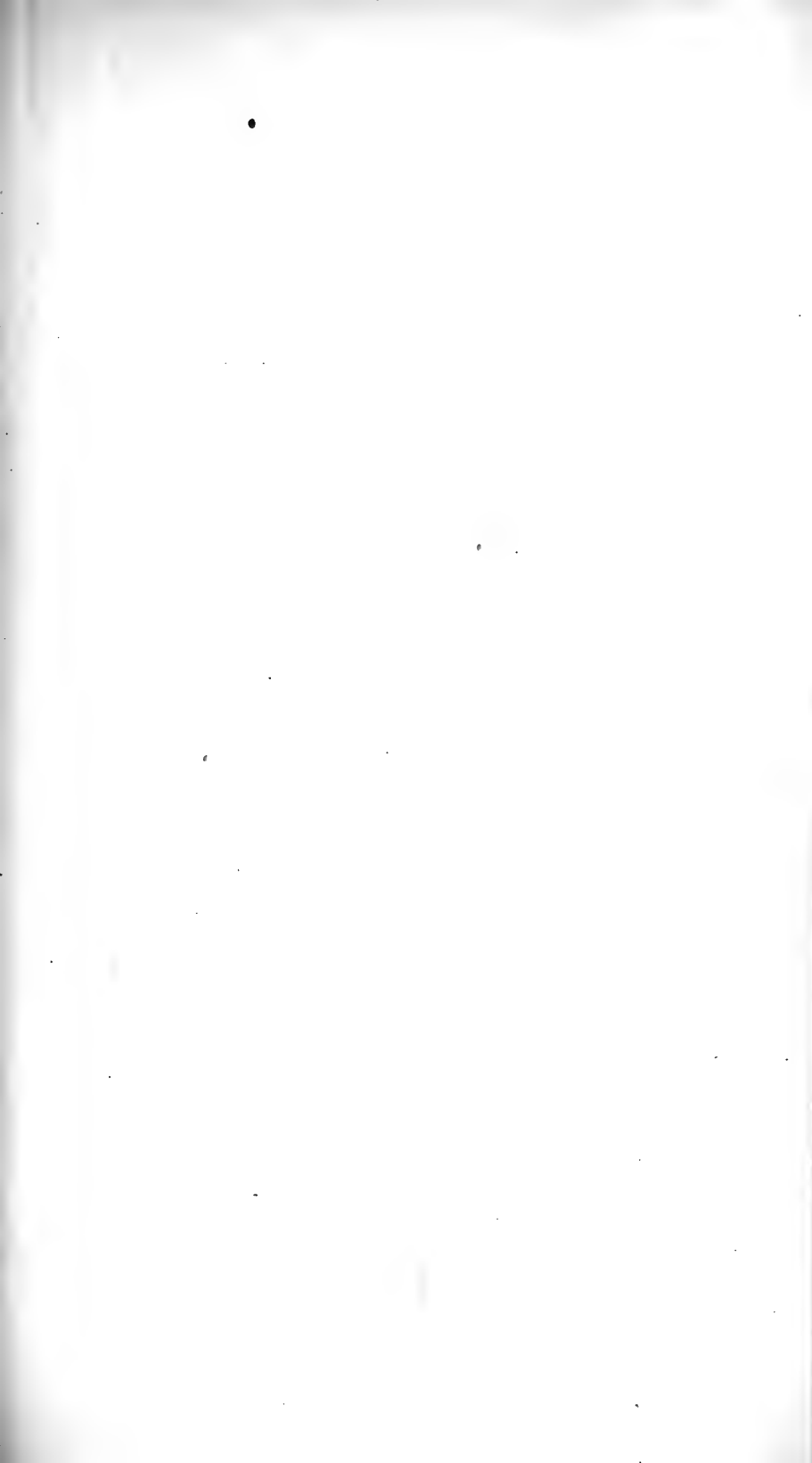
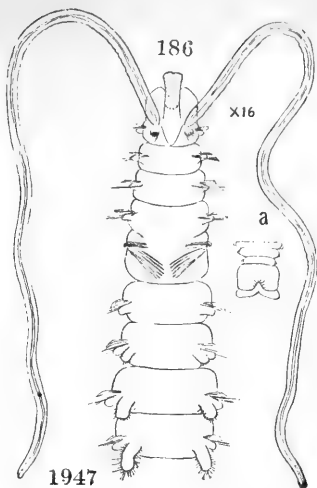


PLATE XLIII.

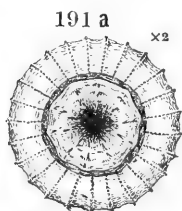
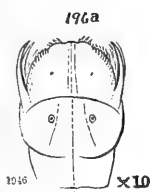
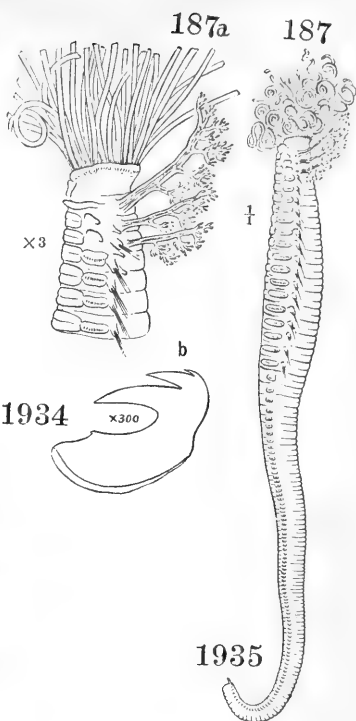
- FIG. 186. *Dipolydora concharum* V. Dorsal view of the head and anterior segments, enlarged sixteen diameters; *a*, caudal segments.
- FIG. 187. *Lepræa abyssicola* V. Side view, natural size.
- FIG. 187 *a*. The same. Side view of the head and anterior segments, enlarged three diameters; *b*, one of the uncini, enlarged three hundred diameters.
- FIG. 191. *Priapulid*, sp., natural size.
- FIG. 191 *a*. The same. Front view of the anterior end, enlarged two diameters.
- FIG. 192. *Phascolosoma*, sp., natural size; *a*, the same, ventral view of the anterior end; *d*, one of the openings of the segmental organs.
- FIG. 193. *Tristoma cornutum* Y. Ventral view, enlarged four diameters. From a bill-fish. Type specimen, drawn from life.
- FIG. 194. *Tristoma lœve* V. Ventral view, enlarged four diameters. From a bill-fish. Type specimen, drawn from life.
- FIG. 195. *Cerebratulid* *luridus* V. One-half natural size. Drawn from life.
- FIG. 196. *Sagitta gracilis* V. Dorsal view, enlarged four diameters.
- FIG. 196 *a*. The same. Dorsal view of the head, enlarged ten diameters. From a specimen taken at Wood's Holl, at the surface.



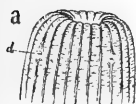
1945



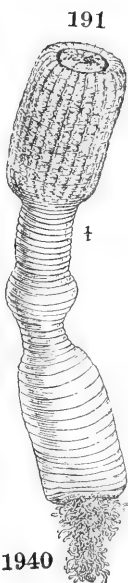
1947



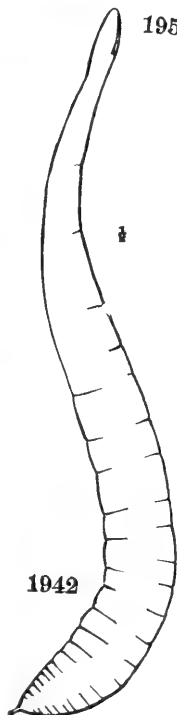
1941



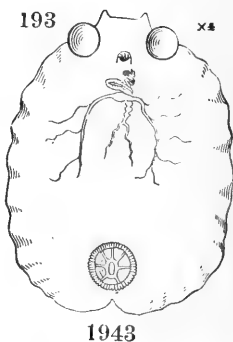
192



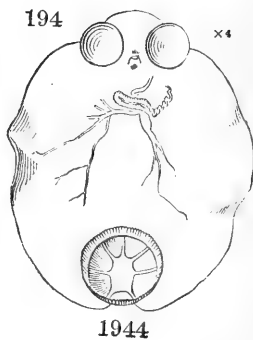
1940



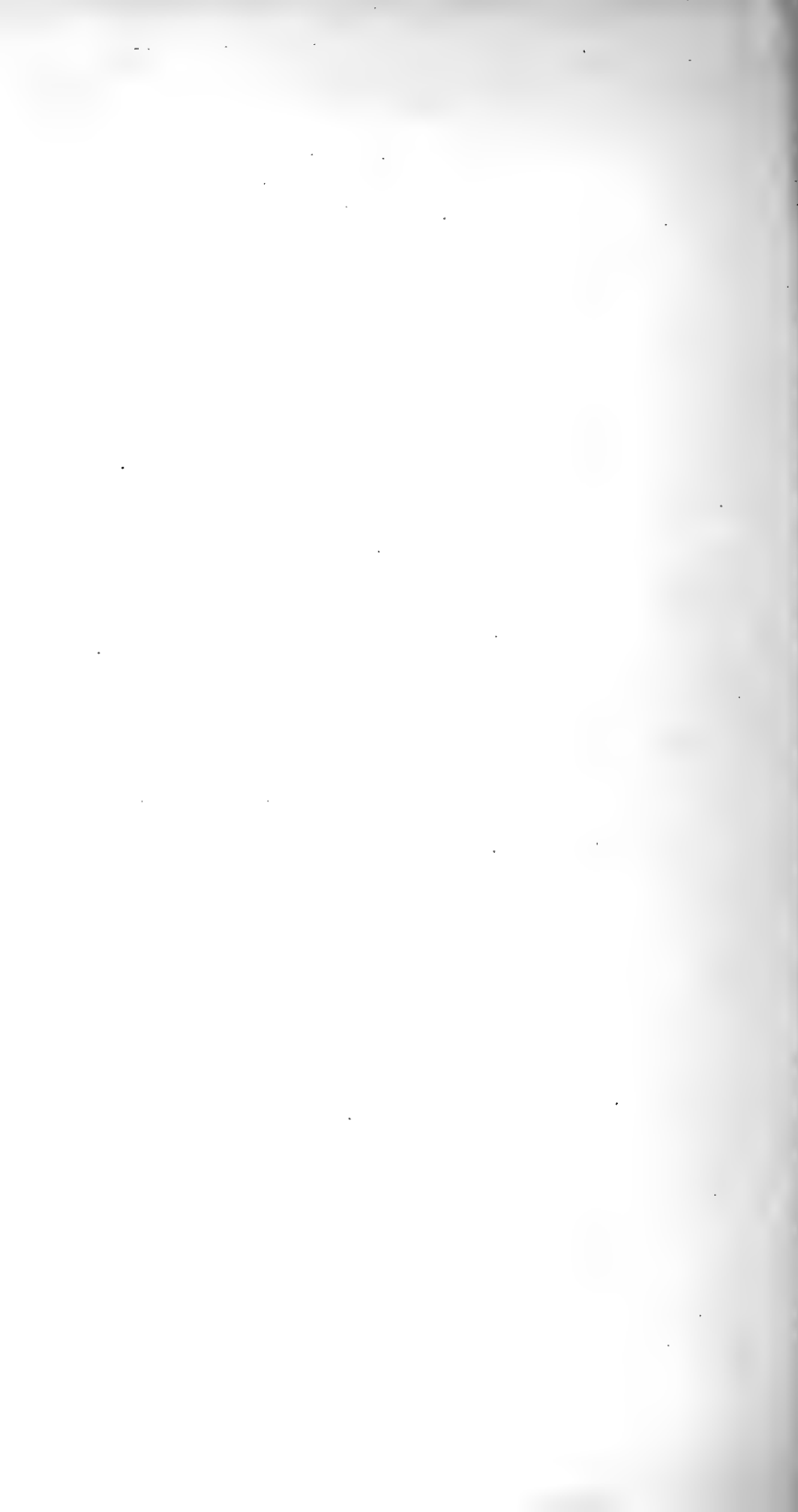
195

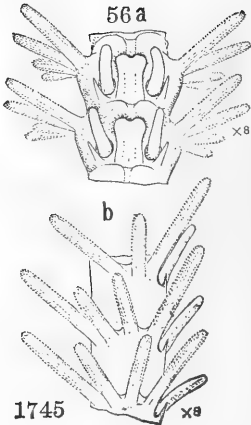
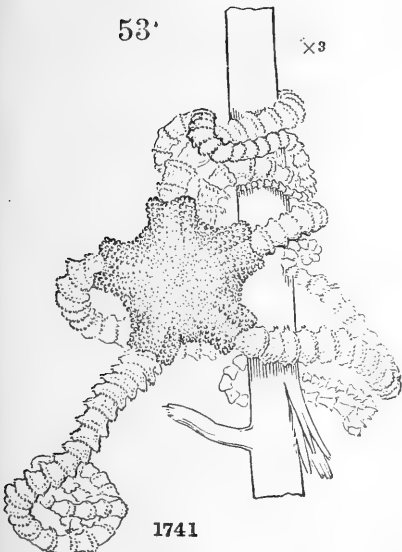
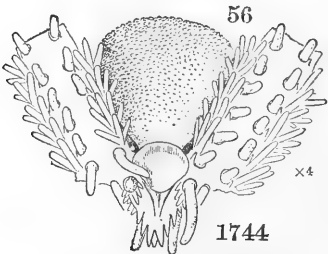
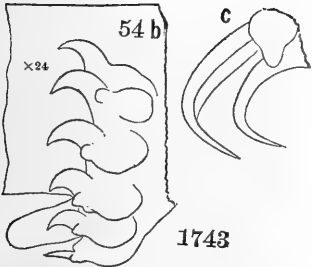
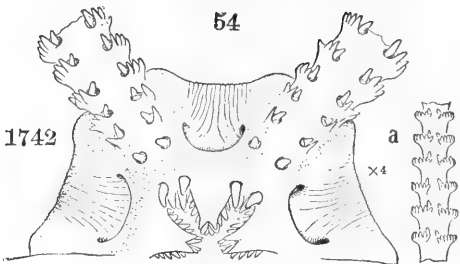
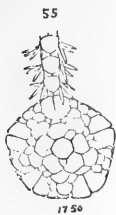


1943



1944





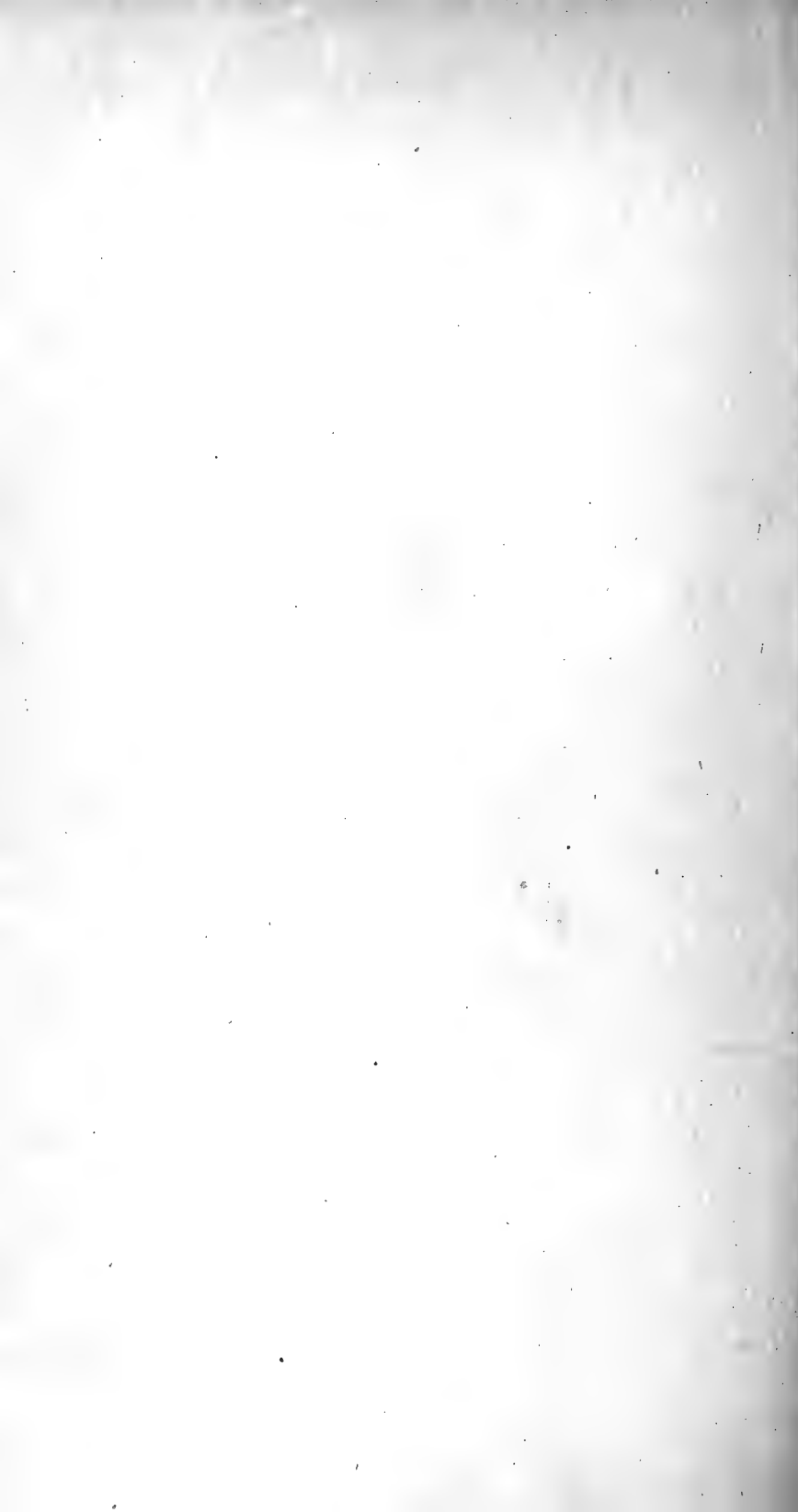
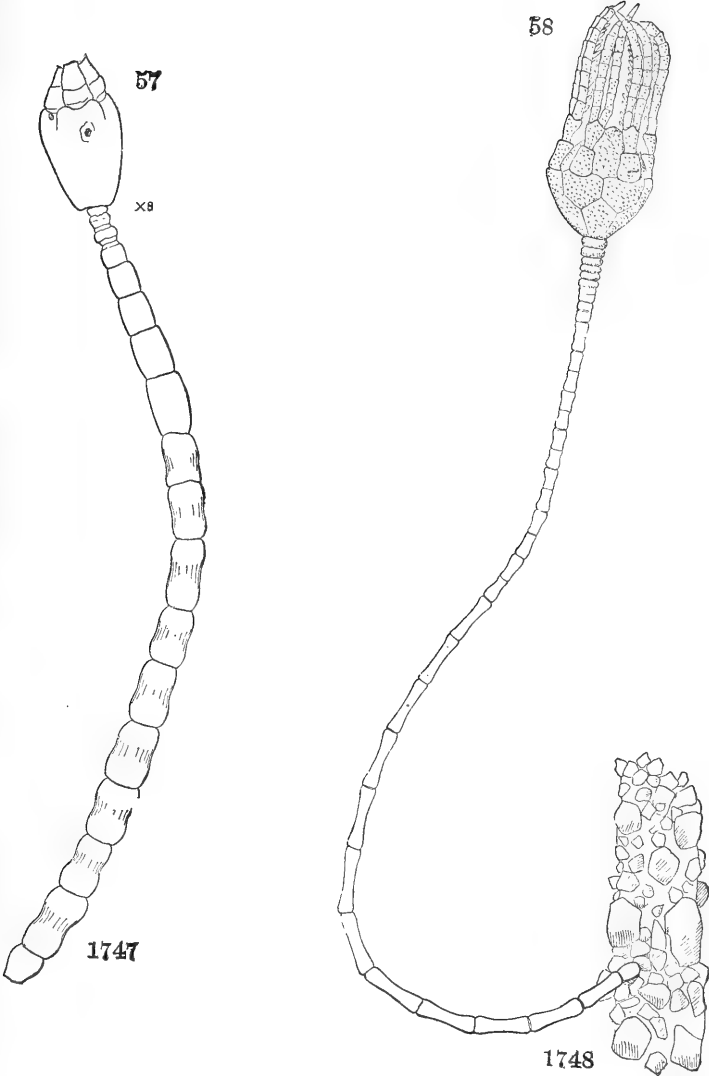




PLATE XXI.

- FIG. 57. *Rhizocrinus Lofotensis*. A young and somewhat imperfect specimen from 640 fathoms, enlarged eight diameters. The base of the stem and the tips of the arms are broken off.
- FIG. 58. *Antedon dentata*, young. In the attached or pentacrinus stage, enlarged about eight diameters.



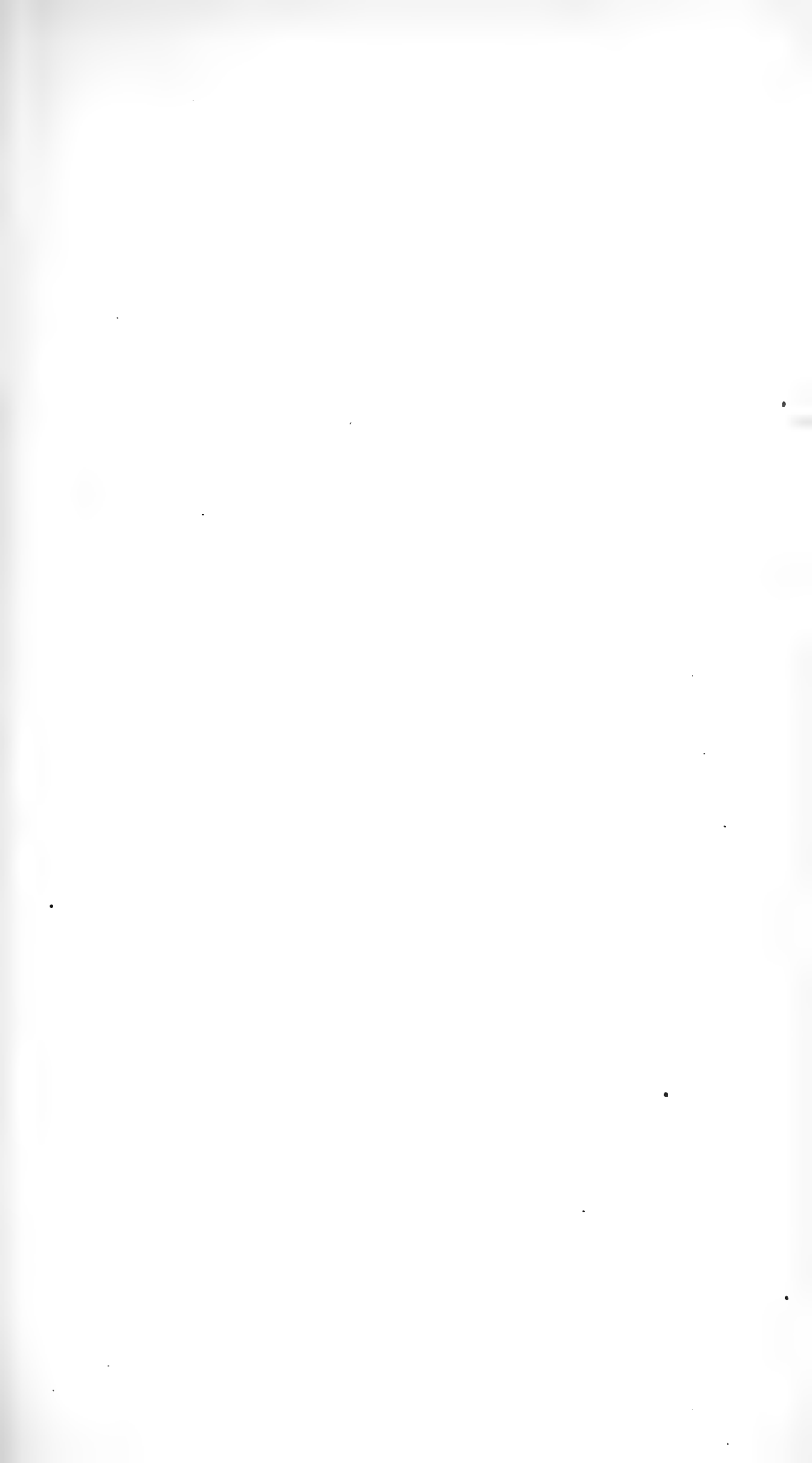


PLATE XXII.

- FIG. 60. *Abralia megalops* V. Ventral surface, enlarged one and one-half diameters.
From a specimen which differed from the type in having raised verrucae scattered on the lower surface.
- FIG. 61. The same. One of the lateral arms, more enlarged.
- FIG. 62. *Leptoteuthis diaphana* V. Dorsal view of the type specimen, enlarged one and one-half diameters.
- FIG. 64. *Eledonella pygmaea* V. One of the lateral arms of the type specimen, enlarged.
- FIG. 65. *Octopus pictus* V. Dorsal view of the type specimen, enlarged four diameters.

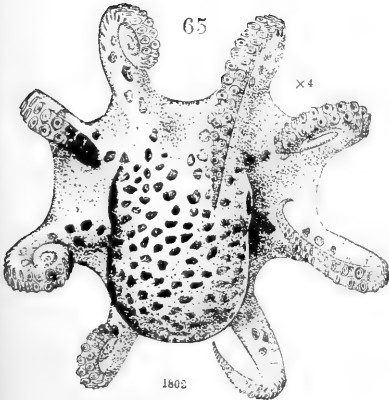
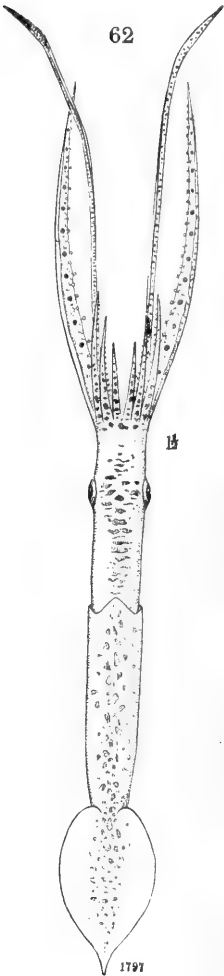
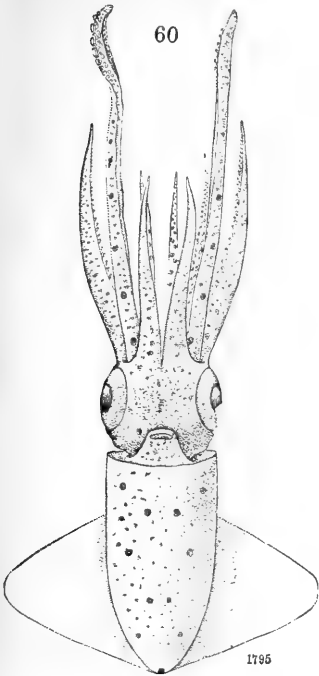






PLATE XXIII.

- FIG. 63. *Argonauta argo*. Side view of the animal, natural size. From a young specimen taken off Long Island, at the surface.
- FIG. 63 *a*. The same specimen. Front view of the shell, natural size.
- FIG. 63 *b*. The same specimen. Side view, natural size.

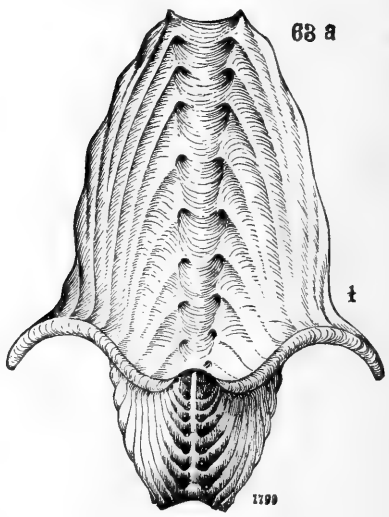
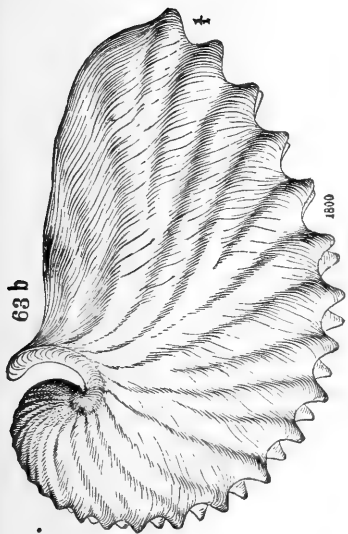
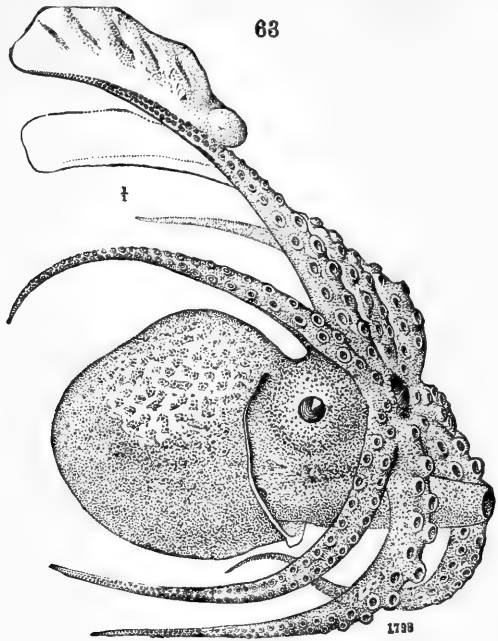






PLATE XXIV.

- FIG. 66. *Pleurotoma Dalli*, enlarged two diameters.
FIG. 66 a. The same. Side view of the anterior whorls, enlarged two diameters.
FIG. 67. *Pleurotomella Agassizii* V., enlarged two diameters.
FIG. 68. *Pleurotomella Bairdii* V. Female, enlarged one and one-half diameters.
FIG. 69. *Pleurotomella Pandionis* V., enlarged one and one-half diameters.
FIG. 70. *Pleurotomella Benedicti* V. & S., enlarged three diameters.
FIG. 70 a. The same. To show nuclear whorls, enlarged twenty-two diameters.
FIG. 71. *Pleurotomella Sandersoni* V., enlarged six diameters.
FIG. 71 a. The same. To show nuclear whorls, enlarged twenty-two diameters.
FIG. 72. *Pleurotomella Saffordi* V. & S., enlarged four diameters.
FIG. 73. *Pleurotomella bandella*, enlarged four diameters.
FIG. 74. *Pleurotomella Emertoni* V. & S., enlarged three diameters.
Fig. 68 was drawn by Ensign W. E. Safford, U. S. N. The others, by J. H. Emerton.

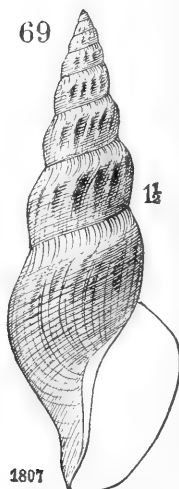
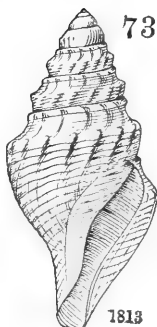
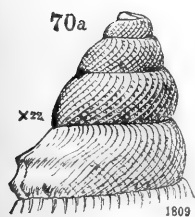
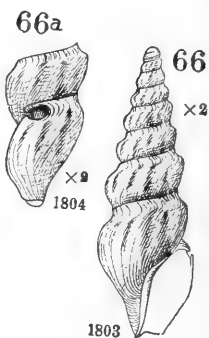
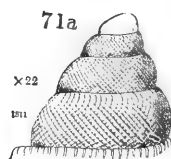
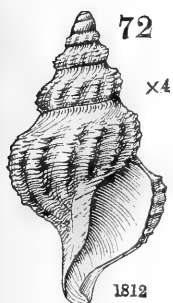
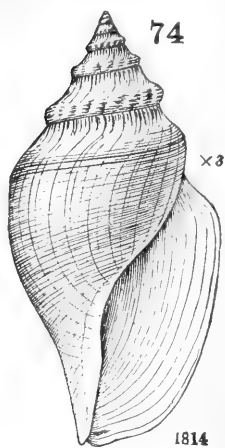
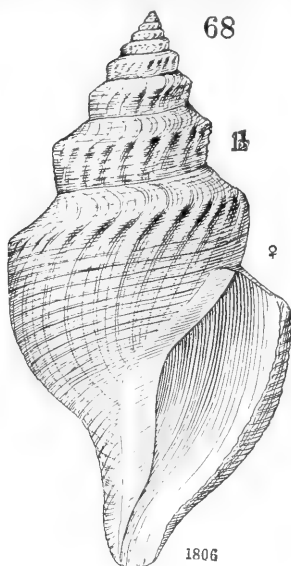
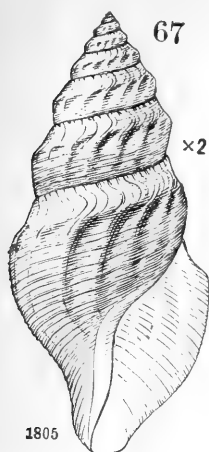




PLATE XXV.

- FIG. 75. *Pleurotomella Bruneri* V. & S., enlarged six diameters.
FIG. 76. *Pleurotomella Catherinæ* V. & S., enlarged four diameters.
FIG. 76 a. The same. To show nuclear whorls, enlarged twenty-two diameters.
FIG. 77. *Taranis pulchella*, enlarged eight diameters.
FIG. 78. *Typhlomangilia Tanneri* V. & S., enlarged three diameters.
FIG. 79. *Marginella borealis* V., enlarged two diameters.
FIG. 80. *Buccinum abyssorum* V., enlarged one and one-half diameters; *a*, the operculum.
FIG. 81. *Sipho profundicola* V. & S., enlarged one and one-half diameters.
FIG. 82. *Sipho glyptus* V., enlarged two diameters.
FIG. 86. *Cingula Jan Mayeni*, enlarged eight diameters.
FIG. 90. *Scalaria Grænlandica*. Dorsal view of the animal with the proboscis extended, and the two anterior whorls, enlarged about four diameters.
FIG. 91. *Scalaria Dalliana* V. & S., enlarged six diameters.
FIG. 92. *Scalaria Pourtalesii* V. & S. Female, enlarged three diameters.
FIG. 93. *Scalaria Leeana* V. Front view of an imperfect specimen, enlarged six diameters.
FIG. 94. *Scalaria Andrewsii* V., enlarged eight diameters.

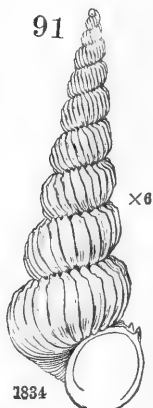
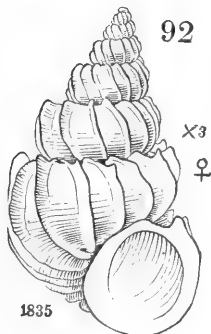
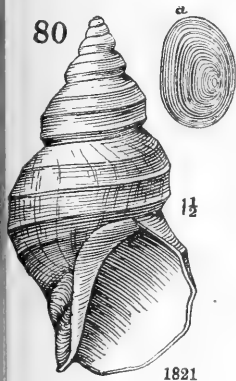
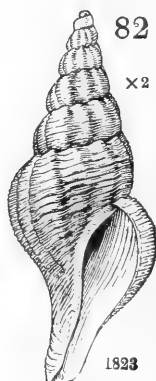
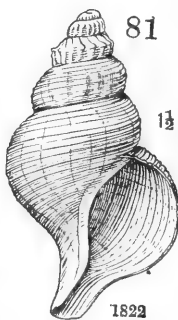
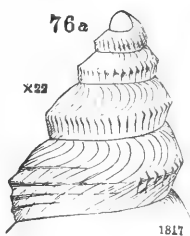
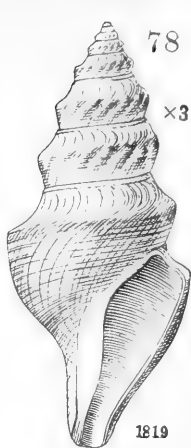
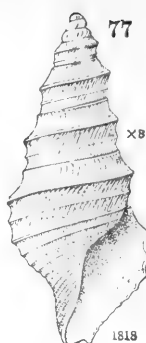
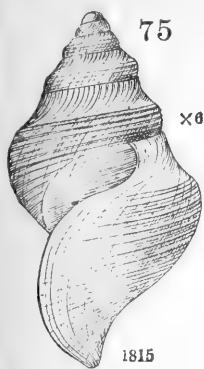


PLATE XXVI.

- FIG. 83. *Dolium Bairdii* V. & S. Male, enlarged one and one-half diameters.
- FIG. 83 a. The same. Animal of the male, two-thirds natural size.
- FIG. 84. *Benthodolium abyssorum* V. & S., enlarged one and one-half diameters; a, operculum of the same specimen.
- FIG. 84 b. The same. Part of the odontophore, enlarged one hundred diameters.
- FIG. 85. *Torellia fimbriata* V. & S. Male, enlarged two diameters.
- FIG. 87. *Fossarus elegans* V. & S., enlarged eight diameters.
- FIG. 88. *Sequenzia formosa*, enlarged ten diameters.
- FIG. 88 a. Operculum of the same.
- FIG. 89. *Sequenzia eritima* V., enlarged ten diameters.

PLATE XX.

- FIG. 53. *Astrochela Lymani* V. Abactinal surface of the type specimen, which is not full-grown, attached to a branch of *Acanella*, enlarged three diameters.
- FIG. 54. *Astronyx Loveni*. Part of the actinal surface of a small specimen, enlarged four diameters; *a*, portion from the distal part of one of the arms, ventral side.
- FIG. 54 *b*. One of the lateral rows of hooks and tentacles from the basal part of an arm, enlarged twenty-four diameters; *c*, two of the hooks from the distal portion of an arm.
- FIG. 55. *Amphiura tenuispina*. Abactinal surface of a small specimen, enlarged about four diameters. From a camera lucida drawing by the author.
- FIG. 56. *Ophioscolex quadri-spinus* V. Actinal surface of a portion of the disk and arms, enlarged four diameters.
- FIG. 56 *a*. The same. Portion of an arm from near the base. Ventral surface, enlarged eight diameters; *b*, the same, side view, showing the basal joints, which sometimes have five spines.



	Page.		Page.
Rail	7	Steel forgings	21
Rake dredge, Chester	90	Steerage	10
Ratchet crank	55	Steering gear	16
Reel, measuring	60	auxiliary	16
Reeling engine	46, 80, 81	steam	50
dimensions of	47	Stern-pipes	18
weight of	47	Stern-post	4
Reverse bars	5	Store-rooms	10
Reversing gear	21	Strainer, description of	94
Royal Society's proceedings	76	Stringers	5
Rudder	16	hold	6
attachments	10	Sturtevant exhaust fan	39
Rudder-chains	17	Table of reductions for temperature	76
Safety catches	35	sieve	93
hooks	80	Tangle bar	91
Sails, dimensions of	3	Tangles, dimensions of	92
Salinometer, Hilgard's ocean	75	nomenclature of	91
Sands' cup	62	Tanner, Z. L.	1, 2, 47, 68
Schroeder, Seaton	61	Tanner's deep-sea thermometer case	69
Screw-propellers	18, 22	thermometer case	72, 73
dimensions of	22	sounding machine	55
Screws, thrust of	24	description of	56
Sea-valves	18	Temperature, table of reductions for	76
Seine-boat	15	Thermometer case, Tanner's improved	69, 72, 73
Serial temperatures	102	Thermometers for air and surface tem-	
description of taking	100	peratures	73
Shaft brackets	18	Miller-Casella deep-sea	73, 74
Sigsbee, C. D.	62, 79, 88, 96, 98, 99	Negretti & Zambra	69, 71, 74, 103
Sigsbee's Deep-sea Sounding and Dredg-		Size's	70
ing cited	64, 75, 88, 9	Thompson, William	62
detacher	62	Thorpe & Rücker	76
gravitating trap	96	Tiller, spare	17
description of	97	Transferring-wire	60
nomenclature of	97	Traveling-guide	46
working of	99	Trawl, beam	83
reel	54	deep-sea	81
sounding machine	9, 51, 60, 100	dimensions of	82
sounding machine, described	52	description of haul of	100
water-specimen cup	64, 69	dimensions of improved beam	85
Sinkers	63	small beam	87
Sixe's thermometer	70	improved beam	85
Small beam trawl	87	small beam	87
dimensions of	87	weights	91
Smith, James A.	93	dimensions of	91
Sounding, description of method of	100	Trawling, description of	103
engine	47	Tuscarora, steamer	62
machine, Sigsbee's	51, 52, 60, 100	Valve	18
Tanner's	55, 56	Valve, Watson & McDaniel	47
piano-forte, wire for	58	Vandalia, U. S. ship	40
wire, lamp for soldering	59	Ventilation	38, 39
Spars, dimensions of	2	Verrill, A. E.	91, 93
Specific gravities	102	Wardroom	11
description of taking	100	entrance to	7
Speedwell, steamer	93	Warming	33
Splice, long	80	Washburn and Moen Manufacturing Co.	58
May's wire	59	Water-bottle, care of	68
Splicing wire, methods of	59	improved	66
to stray line, method of	60	nomenclature of	67
Sprengel pump	33	origin of	68
Steam machinery	18	preparation for use	67
steering gear	50	Water densities	75
windlass	48	how to obtain a specimen of	68
dimensions of	49	specimen cup, Sigsbee's	64

	Page.		Page.
Watson & McDaniel valve.....	47	Wing nets, dimensions of.....	87
Webster and Horsfall.....	58	Wire rope.....	45, 46, 47
Weights, additional.....	21	dimensions of.....	47
Whale-boat.....	15	record of velocity of.....	46
Windlass, steam.....	48	weight of.....	47
dimensions of.....	49	Wiring, electric.....	32
Wing net, Chester's.....	84	Wise motor.....	39
dimensions of.....	84	Wood, William Maxwell.....	15
Wing nets.....	84, 86		



II.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER ALBATROSS FOR THE YEAR ENDING DECEMBER 31, 1883.

By Lieut.-Commander Z. L. TANNER, U. S. N., *Commanding.*

At the close of my last report the vessel was at anchor off Blackstone Island, Potomac River, bound from Wilmington, Del., to Washington, D. C., on her trial trip.

At 6.20 on the morning of January 1 we got under way and steamed up the river. A serious difficulty had been experienced in working the engine promptly, the trouble arising partly from the crank angle (145°) and partly from insufficient power of the reversing engines. At 11.30 a. m., when off Quantico, Va., we commenced working the engines by signal in order to test the efficiency of the reversing gear and the practicability of working the engines with this crank angle. During the practice the starboard low pressure valve guide was broken by the slamming of the links, the reversing engines not having sufficient power to control their movements. After this practice we started ahead on the port engine and anchored off Giesborough Point, at 4.20 p. m. At 2.45 p. m. the following day we got under way and steamed up to the navy-yard. Several mechanics from the Pusey and Jones Company's yard came around with the ship and were engaged in finishing up work in the engineer's department.

On the 15th of January we received Sigsbee's deep-sea sounding machine from the National Museum, where it had been on exhibition since its completion in July last.

On the 16th the starboard engine was worked from 1.45 to 2.30 p. m. under the direction of Mr. C. W. Copeland, the designer, and in the presence of Mr. C. W. Pusey, engineer of the Pusey and Jones Company, Passed Assistant Engineer G. W. Baird, U. S. N., and others. The reversing engines worked much better, but it was demonstrated to the satisfaction of Mr. Copeland that they had not sufficient power to move the valves promptly or to control their motion, and the order was then given for the construction of more powerful reversing engines, from designs furnished by Passed Assistant Engineer G. W. Baird. It was then decided that the vessel should return at once to Wilmington for this purpose as well as to change the crank angles from 145° to 90° .

We were detained by ice in the Potomac until February 10, during which time the general work of completing the ship, such as painting, finishing wiring of electric plant, and numerous details in the engineer's department, was carried on. At 9.45 a. m. on the latter date we left the navy-yard and arrived at the wharf of the Pusey and Jones Company, Wilmington, Del., at 6.20 p. m., February 13.

Work upon the contemplated alterations was commenced immediately and pushed forward with rapidity. All decks except those of the cabin, wardroom, and rooms in the deck-house were calked. On the 16th of March 4,000 fathoms of dredge rope were put upon the reel.

On March 21, the alterations being completed, we left the builders' yard at 10.30 a. m., and steamed down the Delaware, anchoring under the breakwater at 5.50 p. m. The new reversing engines were found to have sufficient power, which, combined with the advantageous change in the crank angle, enabled all signals to be answered with promptness and certainty. At 6.54 the following morning we got under way and stood to the southward and eastward, and at 3.20 p. m. sounded in 519 fathoms, the bottom being green mud. Put over the deep-sea trawl, veering to 820 fathoms on the dredge rope. At 5.11 it was landed on deck, containing several rare species of deep-sea fish. The current number of this haul is 2,001. The vessel remained hove-to from the time the trawl was landed on deck until midnight and then started ahead south-southwest, the wind blowing at the time a moderate gale from northwest. It moderated towards morning, and at 5.50 a. m. we sounded in 641 fathoms (haul 2,002) green mud, and at 6.05 put over the beam trawl, veering to 900 fathoms on the dredge rope. At 7.40 the trawl was landed on deck. The haul was successful; time going down 25 m., coming up 30 m.

Haul 2003: At 8.44 a. m. we sounded in 641 fathoms. The sounding wire parted while heaving in, resulting in the loss of the lead and thermometer. At 8.55 the beam trawl was put over and 950 fathoms veered on the dredge rope. At 10.46 the trawl was landed on deck with very little in the net, owing, probably, to its having failed to reach the bottom.

Haul 2004: At 11.10 a. m. we sounded in 102 fathoms green mud, broken shells, and put the trawl over at 11.17, veering to 208 fathoms. At 11.52 the trawl was up, containing a light load of star-fish, pole flounders, &c.

Haul 2005: At 11.52 a. m. sounded in 82 fathoms blue mud, sand, and broken shells. At 11.55 put over the beam trawl, veering to 100 fathoms. At 12.27 it was landed on deck, containing only a small marbled shark.

Haul 2006: At 12.58 p. m. we sounded in 512 fathoms blue mud, fine sand. At 1.10 put over the beam trawl, veering 800 fathoms. It came up at 2.11, foul and empty.

At 2.15 p. m. we started ahead full speed for Washington. Made Cape Charles light at 8.55 p. m., and Cape Henry at 9.38. The morning of the 24th opened with a fresh gale from northwest, moderating to-

wards evening. At 10.10 a. m. we passed Point Lookout and entered the Potomac River. At 3 p. m. we met the Fish Hawk bound down, and at 7.10 p. m. anchored for the night off Alexandria, Va. We got under way at 8.20 a. m. on the 25th and steamed to the navy-yard, Washington, D. C.

The sounding and dredging during the trip was for the purpose of testing the apparatus, which was found to work satisfactorily with the exception of a few matters of detail, which were easily remedied. Experiments were also made with the submarine electric light by Messrs. Moore and Britton of the Edison Company, who made the trip for the purpose. The apparatus consisted of three incandescent lamps fixed to a brass plate which formed the base of a double glass globe enveloping them. The lamp failed to act satisfactorily; water entering when it was lowered 200 feet. An ordinary 16-candle B lamp was used successfully at a depth of 150 feet, this being the length of its cable.

We remained at the navy-yard until April 24, making preparations for the season's work of deep-sea exploration. Boiler-makers were at work on the boilers most of the time while we were in port. In fact there has been more or less work on them whenever fires have been hauled.

At 8 a. m., on that date, we left for a cruise under the following orders, viz:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 10, 1883.

SIR: As soon as you can be ready for the service (of which you will give me a week's notice), you will go to sea for the purpose of investigating the conditions which govern the movements of the mackerel, menhaden, bluefish, and other migratory species along the coast of the United States in the spring, commencing your investigations off Hatteras, or in the region where these fish usually make their first appearance, and following up the schools in their movements.

The special work to be performed will be to determine the rate of progress of the fish along the coast, their comparative abundance and condition, the places where they first show themselves, the physical condition of their surroundings as to temperature and currents of the water, its chemical and biological peculiarities, &c.

You will endeavor to ascertain whether the appearance of the fish at or near the surface depends upon the condition of temperature, wind or sky, and also, by the use of the apparatus at your command, what character of food in the water seems to determine their movements. You will cause examination to be made of the stomachs of such of these fish as you can capture and carefully preserve a portion at least of the contents of the stomach for immediate or future examination.

Should you deem it expedient you will cruise off the coast a sufficient distance to determine the outward line of motion of the fish, and you will communicate to such fishing vessels as you may meet any informa-

tion that may enable them the more successfully to prosecute their labors. The time of this work is left to your discretion. You will whenever you touch at any port of the United States send a telegram to me and await instructions as to further operations, if there be nothing to detain you.

You will give to the naturalist of the expedition all possible facilities for collecting and preserving such specimens as you may meet during the cruise.

Very respectfully,

SPENCER F. BAIRD,
Commissioner.

Capt. Z. L. TANNER,
Commanding Steamer Albatross.

P. S.—The operations of dredging and trawling should be carried on as frequently as opportunity offers; and if no suitable bait can be had, the trawling line should be used for the purpose of determining the currents of desirable fishing grounds.

At 5.45 p. m. we anchored for the night in Cornfield Harbor with the intention of swinging ship the next day for compass observations. At 5.45 the following morning we got under way and swung ship, first with starboard helm, then with port, observing azimuths on every point. She was then listed, first 5° to starboard, then $4\frac{1}{2}^{\circ}$ to port, and azimuths taken on every other point for heeling error.

Lieutenants Wainwright and Diehl, U. S. N., were sent by the Bureau of Navigation, Navy Department, to make magnetic observations. They assisted in swinging ship, and at 11 a. m. went on shore to vibrate the vertical and horizontal needles. After completing observations for heeling error, the needles were vibrated in the standard binnacle, the compass being unshipped for the purpose. The latter observations were continued after dark, light being furnished by an ordinary 16-candle B electric lamp attached to a flexible wire. Experiments were made as to its effect upon the compass and the delicate magnetic needles, but they were not perceptibly affected. The magnetic observations were completed about 8 p. m., when we started for Fort Monroe to land Lieutenants Wainwright and Diehl, who were to return to Washington. The vessel was put under low speed and arrived at 5.45 a. m., April 26, when the officers were landed and the steward sent to market; and at 8 a. m. we got under way and proceeded to sea. After passing Cape Henry we stood to the southward, parallel with the coast, keeping a careful lookout at the mast-head and on deck for schooling fish, but none were seen, although the weather was clear and pleasant with light winds and smooth sea.

We made Hatteras light at 10.20 p. m., and hove to for the night, drifting slowly off shore. The search for mackerel was resumed in the morning and two hauls of the trawl were made during the day, one only being successful; the trawl fouling a wreck or other obstruction on the bottom during the second haul, it was lost with eighty-five

fathoms of rope. Several soundings were taken with the Sigsbee machine, and towards evening we steamed in shore heaving to finally to the eastward of Hatteras light, where mackerel would be most likely to appear if passing the cape.

We stood off shore again on the morning of the 26th and made two attempts to work the trawl in the Gulf stream. In the first instance it came up foul, and in the second the trawl was lost, only a few fathoms of rope being lost with it. After cruising actively during the day we stood inshore towards evening, and at 8.30 p. m. hove to off Bodies Island light. While in the Gulf stream to-day large numbers of black fish and porpoises were seen about the ship. The weather was clear and pleasant with light southwest wind. No indications of mackerel.

On Sunday morning, April 29, we stood inshore and hove to for several hours, then steamed off shore. The weather was clear during the early part of the day but clouded over about noon, and at 2 p. m. we had a thunder squall from southwest, the wind shifting to northwest and northnortheast blowing a moderate gale during the night with heavy swell. The vessel behaved well and her motions were remarkably easy. No indications of schooling fish.

We hove to till daylight the following morning, then steamed off shore and made three casts of trawl and dredge. The trawl and 1,380 fathoms of dredge rope were lost on the last haul, the accident being caused by the dredge block at the boom end giving away. Water specimens and serial temperatures were taken in about 700 fathoms. No schooling fish were seen during the day. A temporary dredge block was fitted and, although not suitable for the work, we managed to use it.

The weather cleared during the day and the wind moderated, but there was still a heavy easterly swell. The vessel was hove to for the night.

The submarine lamp was lowered during the evening and the lights extinguished at about 100 feet below the surface. After being lowered 600 feet and hauled up there was nothing remaining but the metal frame.

On May 1 the weather was clear during the morning, clouding up later in the day. At 6.35 a. m. we cast the trawl in 373 fathoms, making a successful haul although we did not accomplish it without accident. The makeshift dredge block was unfitted for its work, causing an injury to the rope which made it necessary to cut and splice it. This occupied most of the day. At 7 p. m. we steamed ahead for Cape Henry, making the light at 12.35 a. m. We then stood to the northward, passing as close in as prudent. A fresh northeaster was blowing and a heavy sea running, making it unadvisable to get into less than 7 or 8 fathoms.

About 6 miles to the eastward of Hog Island light we passed a vessel's mast, the mast-head showing above water. It was apparently fast

to a wreck. Large quantities of drift fire-wood were seen during the morning, probably a vessel's deck-load.

We stood on slowly to the northward as far as the light on Winter-Quarter Shoal, then stood off and on during the night. A thick fog set in at dark. No fish were seen during the day.

May 3 opened with a fresh breeze from northeast, heavy easterly swell and a dense fog. We stood off and on between the light-ship and Fenwick's Island during the day, but saw no fish nor fishermen. The fleet of mackerel fishermen were due in this region, and in order to ascertain their whereabouts we started ahead, and at midnight stood in for Cape Henlopen, sighting it about 7 a. m., the fog having lifted for a short time. At 8 a. m. we boarded the fishing schooner, M. B. Tower, of Portland, Me., which had just arrived on the station. Captain Blake said that he had seen neither fish nor fishing fleet, and would like to know where either or both were.

After parting company with the schooner we ran 30 miles southeast and found vessel after vessel looming up out of the fog. The M. E. Torrey, of Sedgwick, and the Starry Flag, of Gloucester, were boarded. They had taken no fish and had seen none, having just arrived from Sandy Hook. There were they said about 125 schooners farther to the southward.

The weather was somewhat clearer during the afternoon, and, wishing to see what the fleet were doing, we steamed to the southward till 7 p. m., gradually overhauling and passing many vessels. The fog shut down again about dark, and, not wishing to miss the fleet, we hove to for the night. Our steam whistle, which was sounded frequently, and the fog horns of the fishing fleet made a most doleful concert. No mackerel had been seen as yet.

The fog continued on the 5th and there was still quite a swell from the eastward. Schooners were passing us frequently, standing to the southward. During the morning we took three casts of the trawl and rake-dredge in shoal water and then steamed slowly to the southward, watching the movements of such vessels as we sighted in the fog. As no fish had been seen here I determined to stand to the southward and see if we could find them in that region. With this object in view we started at 11 a. m. and steamed to latitude $36^{\circ} 30' N.$, but saw no fish. We then turned to the northward running off and on shore, intending to intercept the fishing fleet in the morning.

The fog continued throughout the day and until about 9 a. m. on the 6th, when it broke away, revealing several fishing schooners, and soon after we saw our first school of mackerel, in latitude $37^{\circ} 03' N.$, longitude $74^{\circ} 54' W.$ They were small fish, and, on speaking the Richard K. Fox soon after, he informed us that he had seen the same school. We then steamed to the southward and westward till 2 p. m., then southeast to latitude $36^{\circ} N.$, but saw no indications of mackerel, after leaving the fishing fleet. At 7 p. m. we changed our course to the northward,

standing off and on toward the fleet, which was sighted at daylight on the morning of the 7th. At 6 a. m., in latitude $37^{\circ} 03' N.$, longitude $75^{\circ} 03' W.$, we sighted several schools of mackerel, most of them being small fish. There were but three or four seines out from a fleet of upwards of 60 vessels in sight at one time.

Having fairly struck the schools in shore, we ran 35 miles to the eastward to ascertain how far they extended seaward. No fish were seen, however, after leaving the locality where we saw them in the morning.

Being in about 800 fathoms at the end of this run we took the opportunity to try the trawl again, and made one very successful haul. During the second one, however, we lost the trawl and 10 or 15 fathoms of dredge rope. The accident was the result of kinking and the fault rests between myself and the dredge rope. I have not yet been able to judge satisfactorily which is responsible for the frequent losses during our present trip.

At 6.40 p. m. we started in shore, and at 11 p. m. hove to 5 miles to the northward of the spot where mackerel were seen in the morning, but neither fish nor fishermen were visible. The weather continued clear and pleasant during the night, and at daylight on the 8th there was a moderate breeze from south. We then ran in shore, sighting Cape Charles and Hog Island lights, and when within 12 miles of the latter turned our head off shore steering east-northeast until 10.45 a. m., when, in latitude $37^{\circ} 22' N.$, longitude $75^{\circ} 15' W.$, we ran into numerous schools of mackerel; many of them were, however, small fish. We put the large towing net over and steamed through several schools, hoping to catch some of the small fish upon which they were feeding. Two specimens only were taken and carefully preserved in alcohol. We tried a gill net for mackerel, thinking we might get a stray fish, but they promptly dove under it whenever they encountered it.

The fishing fleet were not in sight, and wishing to ascertain their whereabouts, we ran 15 miles to the eastward to a point about 18 miles north of the position of the fleet yesterday morning, but neither fishermen nor fish were to be seen. The time had now arrived when it was necessary to return to port for coal, and our head was accordingly turned towards Cape Henry, between 50 and 60 miles to the southward and westward. At 9 p. m. we anchored in Hampton Roads.

At 8.30 a. m. the following day, May 9, we got under way and steamed to the navy-yard, Norfolk, Va., for coal and repairs to boilers and machinery. We finished coaling on the 12th, necessary repairs detaining us until 3.55 p. m. on the 18th, when we left the yard, and, passing the Capes, stood to the eastward, intending to spend the following day in the use of trawl and dredge.

The weather was calm and clear during the evening, but there were indications of wind which, in fact, we got before morning. A line of soundings was taken on the way out to fill a gap on the coast chart. A good lookout was kept also for mackerel and menhaden, but none

were seen. Before arriving on our intended dredging ground it was blowing a moderate gale from northeast, with heavy sea—too rough for our work. The vessel was therefore put head to wind and sea under easy steam until 2 a. m. on the 20th, then put before it, running back to our station by daylight. The wind had moderated in the mean while, but a heavy easterly swell was still rolling in. Later in the day quite a large number of soundings were taken which will be useful in filling gaps on the chart. Porpoises were frequently seen about the ship. The weather was still unsettled and the barometer very low, a dense fog prevailing at intervals.

During the 21st several successful hauls of the trawl were taken. The fog continued with an occasional interval of clear weather. At 5.40 p. m. we steamed ahead for the purpose of making an examination of the coast for schooling fish or fishermen. We passed Barnegat about 10 a. m. on the 22d, and steamed along the coast to Sandy Hook, getting sight of land occasionally as the fog lifted. No schooling fish nor fishing vessels were seen. The barometer was still low, 29.57, and the weather unsettled. Leaving the Hook, we steamed along the southern shore of Long Island during the night, passing Block Island at 8 a. m. on the morning of the 23d. Several fishing schooners were seen in the harbor, but none outside. A heavy southerly swell and thick fog with low barometer induced me to run into Newport, R. I., for a harbor to save coal.

The weather having improved we got under way at 10.40 a. m. on the 24th and ran over to Montauk Point, thence to Block Island and No Man's Land, keeping a good lookout for schools of fish, but saw none. There were several fishing schooners in Newport, and we met quite a number standing in as we were going out. A dozen or more were standing off and on to the southward of Block Island, and occasionally one was seen farther to the eastward, as far even as No Man's Land. There were a large number in the harbor at Block Island, the bad weather of the last few days having probably driven them in there for shelter. From No Man's Land we stood to the southward under very low speed for two hours, during which the arc light was hung over the side near the water to attract fish. We succeeded in drawing quite a number of Mother Carey's chickens around us, and attracted so many salpa to the surface that Mr. Benedict gave up surface towing, saying that he could get nothing else in his net.

I have been anxious to see the effect of this brilliant light on a school of mackerel, but, unfortunately, we have fallen in with none at night. The light was finally taken in and the speed increased to bring us to the lopholatilus ground at daylight. We succeeded in getting a barrel of bait in Newport and proposed setting a trawl line on our best ground for tilefish.

The morning of the 25th opened clear and pleasant with light to moderate breeze from southwest. At 5.15 a. m. we lowered the dinghy

in latitude $40^{\circ} 05' 25''$ N., longitude $70^{\circ} 28'$ W., in 90 fathoms of water, with instructions to set the trawl line north and south, which would bring the southern end in something over 100 fathoms. In the mean time we steamed a few miles to the southward and commenced dredging on our old ground, where we recognized the endless variety of forms which we had taken in former years. At 10.30 a. m. we took the fishermen on board and hoisted the dinghy. They had taken large numbers of dogfish, hake, skate, &c., but no tilefish. Dredging was continued for a while longer in this locality and then we ran to the southward and westward, finally casting the lead in 1,168 fathoms, latitude $39^{\circ} 42'$ N. longitude $70^{\circ} 47'$ W. A set of serial temperatures and water specimens from various depths was taken, and finally the dredge and tangles were put over. They came up about midnight filled with a compact mass of gray ooze and a most tenacious mud or clay which proved to be very rich in foraminifera, about three quarts having been procured from it. The water specimens were carefully preserved for future examination. The combination of incandescent and arc lights was brought into use illuminating the deck and surroundings so perfectly that work was carried on almost as well as in daytime.

As soon as the dredge was up, we steamed to the southward and westward again, and at 6.20 a. m. the following day cast the trawl in latitude $39^{\circ} 29' 45''$ N., longitude $71^{\circ} 43'$ W., depth 588 fathoms. This was a very successful haul, bringing up great numbers of large red crabs and several fish which were not recognized by us. We attempted to keep some of the former alive in a large tub of water, but they all died within twenty-four hours. After the trawl came up we stood to the westward toward the 145-fathom hole of the Coast Survey charts. Occasional casts of the lead were taken in depths of from 801 to 363 fathoms in the hole. We then stood to the southward about two and a half miles and set the trawl line in 74 fathoms, latitude $39^{\circ} 29'$ N., longitude $72^{\circ} 19' 55''$ W., and while the fishermen were away we cast the trawl twice, taking several varieties of fish, star-fish and other forms found in that depth.

After taking up the line, the dinghy returned to the ship with large numbers of dogfish, hake, skate, and two kingfish but no tilefish. We returned to the hole above mentioned after hoisting the boat and cast the lead in 379 fathoms, took a set of serial temperatures, which are worthy of notice, the alternating cold and warm strata showing a most peculiar condition of currents, which may perhaps furnish a clew to the formation of the "hole." A specimen of bottom water was taken also for future examination. The beam trawl was lowered and an interesting haul anticipated, but the light net was not strong enough to bring up the load of mud collected and was torn from the frame.

I am not fully satisfied with our hurried examination of the interesting spot, and trust that we may have an opportunity at some future time to make a more thorough exploration.

The weather was threatening during the afternoon, with falling barometer, and by the time we had finished our observations it was blowing a fresh breeze from southwest with quite a heavy swell. At 7.40 p. m. we started for New York, where we arrived at 9.33 a. m. on the 27th, and anchored off the Battery, where we found the following vessels of the North Atlantic squadron at anchor, viz, the flag-ship Tennessee and ships Vandalia, Kearsarge, and Yantic. The Minnesota and Saratoga were off Twenty-third street, North River.

At 6.20 p. m. the following day we got underway and steamed up to the navy-yard, and at 7.45 a. m. May 31, went into the dry-dock to have the ship's bottom cleaned and painted.

Lieutenants Wainwright and Diehl reported on board June 1, by order of the chief of Bureau of Navigation, to continue the magnetic survey while the vessel was in dock, and, having completed their work, they left on the 3d for Washington.

We hauled out of dry-dock on June 6, coaled ship on the 7th and 8th, and were engaged in the general work of overhauling, painting, &c., until 7 a. m., June 17, when we left the yard for Washington, D. C., where we arrived at 8 a. m. on the 19th, and were employed making general preparations for the season's work until 10 a. m., July 6, when we left the yard and steamed down the Potomac under the following orders:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., June 26, 1883.

SIR: As soon as the Albatross is in condition for leaving the Washington Navy-yard, you will proceed to sea, taking on board Capt. Jacob Almy, of New Bedford, as fisherman expert.

Your object will be to obtain as much information as possible in regard to the movements of the mackerel, menhaden, and other sea fishes determining, as far as possible, their numbers, size of schools, distances of the schools apart from each other, the range of the species in latitude and longitude, the conditions which affect them, especially those of temperature at the surface and below, the food, condition of the sky, &c.

You will give Captain Almy every opportunity to test practical questions in this connection, and instruct him to use the net and other fishery apparatus on board in ascertaining the whereabouts and numbers of fish when they do not show at the surface, taking samples for identification whenever practicable.

As soon as you have been out sufficiently long to make a satisfactory investigation, you will report at Wood's Holl, Mass., for further duty.

Very respectfully, yours,

SPENCER F. BAIRD,
Commissioner.

Capt. Z. L. TANNER,
Commanding Albatross, Navy-Yard, Washington, D. C.

At 9.25 p. m. we anchored in the Chesapeake between Smith's Point and Wicomico River, and the following morning sent Capt. Jacob Almy in the steam-cutter to board such fishing vessels as he considered advisable out of a fleet of between sixty and seventy schooners engaged in taking menhaden at that point. We worked to the southward, boarding such fishing vessels as came in our way until we reached Mob Jack Bay, where an extensive fish factory was visited and much information obtained. We then went to Hampton Roads for a harbor.

At 4.15 a. m., on the 8th, we got under way and proceeded to sea. Having passed the Capes, we stood to the northward, as near the coast as practicable, keeping a lookout for schooling fish or fishing vessels. Large schools of menhaden were seen off Hog Island, but no fishermen, and we saw no fish between this point and the Delaware Breakwater except porpoises, which were about the ship in large numbers during the afternoon. At 8 p. m. we anchored at the breakwater for the night.

The weather, which had been delightful throughout the day, changed in the evening and was squally and unsettled during the night. The following morning the fishing vessels and fish factories in the vicinity were visited, and at 1 p. m. we got under way and stood to the northward, keeping a lookout for fish and fishing vessels, but saw neither until in the vicinity of Sandy Hook. Several vessels were boarded in the Lower Bay, and the fish factories at Port Monmouth visited by Captain Almy. A large number of vessels, both sail and steam, were fishing in the Lower Bay. At 11.10 a. m. we left Sandy Hook and steamed along the Long Island shore. Occasional schools of menhaden were seen as we approached Fire Island, where several fishing vessels were at work. The schooner Mary Wood was boarded at this point. Occasional schools were seen as far as Shinnecock, but none between that point and Montauk.

At 8.25 a. m., July 11, we anchored off Greenport, Long Island, and the fish factories in that vicinity were visited. We then went to Promised Land, Napeague Bay, Long Island, where several factories were visited by Captain Almy.

At 4 a. m., July 12, got under way and steamed up Long Island Sound, calling at various factories, finally anchoring for the night off Throgg's Neck. Menhaden fishermen were seen at work as far west as New Haven. Nine steamers were seen at one time during the day.

We were under way at 7.30 a. m. on the 13th, running to the eastward through the Sound. Several fishing vessels were boarded during the day, and the extensive factory of Luce Brothers at Niantic, Conn., was visited. We then stood to the eastward under low speed, keeping a lookout for fish during the night, but none were seen. At daylight, on the morning of the 14th, we were near Gay Head, and at 6.35 anchored in Wood's Holl.

The reports obtained from fishing vessels and factories by Capt. Jacob Almy are appended. To save time a list of questions was pre-

pared and numbered, the number and answer only being written by the boarding officer; this rule was followed on board of fishing vessels, but at the factories he has adopted the narrative form, which I have retained.

It will be observed, by reference to the reports, that menhaden are unusually plentiful this season from the Chesapeake to Montauk, the ground covered by our investigation. It will be seen, also, that the fish are generally below the average in size and condition, the product varying from one to two gallons of oil to a thousand fish.

The fishermen of the Chesapeake whom we interviewed were unanimous in their belief that the menhaden taken there were a local fish, that they spawned in the bay, and remained there through the winter. Some of them report having seen full-grown menhaden in winter, and large masses of young fish. The Fish Hawk took menhaden from 3 to 6 inches in length early in March, 1882, in the Chesapeake, which would seem to favor the theory that they wintered there.

We saw no fishing outside of the capes of the Chesapeake and none inside the Delaware capes. In the latter case their fishing grounds extend from Fenwick's Island to Hereford light. The tides are too strong inside the capes to use the purse-seine with success.

The New York grounds may be said to extend from Barnegat to Fire Island, large numbers being taken in the Lower Bay. Vessels to the eastward of Fire Island usually deliver their catch to factories in Long Island Sound, and fish taken in the Sound are delivered to factories in the vicinity. It would seem by the report that very few edible fish are taken with the menhaden. The quantity varies, however, in different localities.

The first catch of the season is from the pounds before they begin schooling at the surface. There were no mackerel reported between the Chesapeake and Montauk, the invariable reply to the question being that they had gone to the eastward.

It is well understood among fishermen that the temperature of the water has a marked effect upon the movements of menhaden, but there seemed to be very little knowledge as to the actual temperatures required to produce certain results. Some observers, however, stated that they did not school at the surface until the water was about 54°. Clear weather with south and west winds was considered the best for fishing.

Opinions differ somewhat, it will be observed, as to increase or decrease of fish on the Atlantic coast.

On July 7, off the mouth of the Great Wicomico River, in a fleet of about sixty sail, the following questions were asked by Captain Almy, viz:

1. What vessel is this?
2. Whence does she hail?
3. What is the captain's name?

4. Have you seen or taken any fish?
5. What kind?
6. When and where were mackerel and menhaden first seen this season?
7. How fast do schools travel north?
8. In what depths of water are they most likely to be encountered?
9. Any other information that would be of interest?
10. How many menhaden have you caught so far this season?
11. What was your last year's catch?
12. How many fish have you had at your factory so far this year?
13. What is the name of the firm for which you sail?
14. Do you know how many fish were taken for the factory last year?
15. What are the dimensions and size of mesh of your seine?
16. How long do seines last in this climate?
17. Do you catch any other fish among the menhaden?
18. How many men do you carry in your gang?
19. What state of the weather is best for fish to be seen in?
20. How far up the bay do these fish go?
21. Where do menhaden winter?
22. What do they eat?
23. What effect does change of temperature of air or water have upon them?
24. Is their arrival or departure affected by temperature of water?
25. Can you suggest any improvement upon the present method of taking menhaden?

The captain of the first fishing vessel boarded made the following replies, viz:

1. Lizzie Bell.
2. Baltimore.
3. George Ketchum.
4. Yes.
5. Menhaden.
6. 15th of April; schooling May 1; Chesapeake Bay.
7. They remain here and spawn.
8. From 4 to 6 fathoms.
10. Four hundred thousand.
11. Eight hundred thousand.
12. One and a half millions; we work three gangs.
13. G. T. Burgess.
14. No; light catch.
15. Length, 100 fathoms.
16. Six months.
17. Yes; Spanish mackerel.
18. Nine.
19. Southerly winds.

The following replies were made by the captain of the next one boarded, viz:

1. General Carmichel.
2. Town Creek, Md.
3. N. A. Haynie.
4. Yes.
5. Menhaden.
6. 15th June; Chesapeake Bay.
7. They are local and I do not think they leave the bay.
8. From 4 to 10 fathoms.
9. None.
10. Sixty thousand.
11. Two millions.
12. Do not know.
13. Marsh, Booth & Co.
14. Two millions.
15. Length, 120 fathoms; mesh, 2 inches.
16. One year.
17. Yes; some tailors and greenfish.
18. Nine men.
19. Southwest weather; clear.

The captain on board the next one replied as follows, viz:

1. Louisa A. Muir.
2. Baltimore.
3. L. J. Beatley.
4. Yes.
5. Menhaden.
6. 15th April; Chesapeake Bay.
7. They do not go north, but spawn here.
8. From 4 to 10 fathoms.
9. None.
10. Fifteen hundred thousand.
11. Thirteen hundred thousand.
12. Six millions.
13. E. W. Reed & Son.
14. Forty-four hundred thousand.
15. Length, 80 fathoms; mesh, 2 inches.
16. Scarce one season.
17. Yes; a few tailors.
18. Nine men.
19. Southerly weather.

On board the next one replies were made by the captain as follows, viz:

1. Schooner Dager.
2. Tappahannock.
3. A. Tason.

4. Yes.
5. Menhaden; very small.
6. 15th of April; Chesapeake Bay.
7. They are local, spawning here.
8. From 5 to 10 fathoms of water.
9. None.
10. Two millions.
11. Twenty-eight hundred thousand.
12. One and a half millions.
13. N. H. Timbs.
14. No.
15. Length, 100 fathoms.
16. One year.
17. Very seldom.
18. Nine men.
19. Southerly and easterly.

The captain of the next one boarded replied as follows, viz:

1. Harriet Howarth.
 2. Crissvesse, Md.
 3. J. H. Crowder.
 4. Yes.
 5. Small menhaden.
 6. 9th of May; Chesapeake Bay; no mackerel seen.
 7. They are local, spawning here.
 8. From 3 to 6 fathoms.
 9. None.
 10. Two millions.
 11. Do not know.
 12. Nine millions.
 13. E. W. Reed & Son.
 14. Six millions.
 15. Length, 122 fathoms.
 16. One season.
 17. Very few; some tailors, known in New York as bluefish.
 18. Nine men.
 19. Southerly.
- Off Rappahannock Spit, on the same date, boarded the following fishing schooners, and, asking the same questions as above, elicited the following replies, viz:
1. Stephen Hopkins.
 2. Baltimore.
 3. Alvin George.
 4. Yes.
 5. Menhaden.
 6. 1st of May; Chesapeake Bay.
 7. Twenty miles a day.

8. Without regard to depths.
9. Menhaden spawn here.
10. Twelve hundred thousand.
11. Twelve hundred thousand.
12. Two millions; we work two gangs.
13. James & Co.
14. Four millions.
15. Length, 120 fathoms.
16. Two years.
17. Yes; some bluefish.
18. Nine men.
19. Southerly.
20. As far as Annapolis.

Answer on board the next one:

1. Schooner Ostrich.
2. Crisfield, Md.
3. C. E. Ketchum.
4. Yes.
5. Menhaden.
6. In March; in Chesapeake Bay.
7. Fifty miles a day, when outside the capes.
8. From two to five fathoms.
9. Menhaden spawn from Massachusetts to Florida.
10. One million.
11. Did not fish.
12. Five millions.
13. W. D. Hall & Co.
14. Seven millions.
15. Length, 120 fathoms.
16. One season.
17. Yes; a few bluefish.
18. Nine men.
19. Very little difference.
20. As far as Pool's Island.

"The fattest fish known to be caught gave 12 gallons of oil to the thousand. The present value of 1,000 fish is \$1.90. I know these fish to be local; they do not leave this place. We are making at present two gallons of oil to the thousand."

Answers on board the next one visited:

1. Schooner Prowess.
2. Crisfield, Md.
3. A. R. McNamara.
4. Yes.
5. Menhaden.
6. Tenth May; Chesapeake Bay.
7. Depending upon circumstances.

8. From 2 to 10 fathoms.
9. No.
10. Thirteen hundred thousand.
11. Thirteen hundred and forty-seven thousand.
12. Twenty-eight hundred.
13. James & Co.
14. Four millions.
15. Length, 116 fathoms.
16. One season.
17. Yes; a few bluefish and some Spanish mackerel.
18. Nine men.
19. Southerly.
20. As far as the Patuxent River.

Answers on board the next one visited off Rappahannock Spit:

1. Thomas Bell.
2. Baltimore.
3. George P. Squires, post-office address, Whitestone, Va.
4. Yes.
5. Very small menhaden.
6. Fifteenth of April; Chesapeake Bay.
7. Ten miles an hour outside the capes.
8. From five to seven fathoms.
9. The most fish of this class I have seen for years.
10. Twenty-three hundred thousand.
11. Fifteen hundred thousand.
12. Fifty-three hundred thousand, working three gangs.
13. Bellows, Rasquith, Squires & Co.
14. Thirty-seven hundred thousand.
15. Length, 115 fathoms.
16. One season.
17. Yes; occasionally tailors.
18. Eleven men.
19. Easterly.
20. As far as Baltimore.

"When approaching the coast, fish move very slowly; when leaving, very rapidly. Large fish full of ripe spawn were seen on the 10th of October in the mouth of the Rappahannock River."

Answers on board the next one visited off Rappahannock Spit:

1. Schooner Annie.
2. Rappahannock.
3. Edward Sommers.
4. Yes.
5. Very small menhaden.
6. First of May; Chesapeake Bay.
7. Do not know.
8. From 8 to 10 fathoms.

9. None.
10. Eight hundred thousand.
11. One and a half millions.
12. Eighteen hundred thousand.
13. L. H. Irvin & Co.
14. Eight hundred thousand.
15. Length, 115 fathoms.
16. One season.
17. Yes; a few tailors.
18. Ten men.
19. There is no difference.
20. As far as Baltimore.

On the same date, July 7, 1883, Captain Almy visited the menhaden factory of Mr. R. T. Bosman, in Mob Jack Bay, who made the following statement, viz :

"These works were built sixteen years ago, and since then have been in constant operation. Menhaden were formerly very plentiful, but there has been a gradual falling off until the present season. They are now more plentiful than at any time during the past seven years. Two and sometimes three gangs are employed, the average catch being two millions by each gang. The fish make their appearance about the 1st of April, remaining till the latter part of November. I have seen full-grown fish in the bay in winter, and great masses of young fish also; the latter I am confident remain in the bay. I have seen fish taken in November which had just spawned. Five years ago great numbers of young menhaden were driven on the shore by a northeast gale. There are numerous stake-traps here (Mob Jack Bay) catching in their season shad, alewives, hickory shad, weakfish, Spanish mackerel, sheep's-head, pogies, &c. There has been a general decrease from year to year in the quantity of fish taken in the traps. The greatest falling off is in Spanish mackerel, sheep's-head, and weakfish; shad hold their own better than any other fish. Whales are sometimes seen ten miles or more inside the capes, and porpoises come in about the 1st of April, remaining till November. The average yield of oil is about $2\frac{1}{2}$ gallons for 1,000 fish. The scrap is sun-dried, this establishment using no sulphuric acid.

"There are numerous factories in the Chesapeake, one in Back River, one at Cherry Point, and two on Piankatank River. The Back River works is one of the largest in the Bay, running ten gangs, and using 20,000,000 fish annually, the other works using about two millions on the average. The fishermen of the Chesapeake are in high spirits over the abundance of menhaden found in the bay this season."

On July 9, at the Delaware Breakwater, the following replies were received upon boarding fishing vessels, viz :

1. Sloop J. W. Luce.
2. New London.

3. W. F. Saunders.
4. Yes; take them every pleasant day.
5. Small menhaden.
6. From 10th March to 1st April; off Cape Henry.
7. 20 miles in 24 hours.
8. Ten fathoms.
9. Mackerel do not approach the coast so near as menhaden.
10. Two hundred thousand.
11. They did not run last year.
12. One and a half millions.
13. Luce Brothers.
14. Twenty millions.
15. Length, 130 fathoms.
16. One season.
17. Very seldom.
18. Twenty men.
19. Moderate southerly and westerly winds.
20. To the head of navigation.

"I think that the habits of fish are similar to those of birds which go north in summer and return south in winter. I have not seen so many mendaden on the coast before in seven years, and have noticed that the small ones appear in about this interval."

Answers on board the next one:

1. Steamer G. S. Allen.
2. Wilmington, Del.
3. William Spicer.
4. Yes; I take them every day when the weather is favorable.
5. Mendaden of small size.
6. On 15th April, off Delaware Breakwater; as for mackerel, I do not know.
7. Twenty miles in twenty-four hours.
8. From one to fifty fathoms.
9. Sharks are seen in great abundance in this locality.
10. Seventeen hundred thousand.
11. Forty-four hundred thousand.
12. Do not know.
13. Brown & Lennon.
14. This is my first season.
15. Length, 170 fathoms; mesh, $2\frac{1}{4}$ inches.
16. If used steadily three months.
17. Very few; sometimes small bluefish.
18. One gang of fourteen men.
19. Moderate southwest winds.
20. To the head of navigation.

"There are two factories at the Delaware Breakwater, employing three steamers and one sailing gang, fishing six seines."

Answers on board the next one visited :

1. Steamer Quickstep.
2. New London, Conn.
3. F. H. Beckwith.
4. Yes; take them every day.
5. Small menhaden.
6. On 26th of April, both mackerel and menhaden; mackerel off Cape Henry; menhaden off capes of the Delaware.
7. About 25 miles in 24 hours.
8. Shoal water in the spring; deep water in the fall.
9. Sharks are very troublesome to us, and are seen in plenty.
10. Thirty-five hundred thousand.
11. Seven millions.
12. Fifteen hundred thousand.
13. Luce Brothers.
14. New factory; first season.
15. Length, 160 fathoms; mesh, $2\frac{1}{4}$ inches.
16. One season.
17. Very seldom; sometimes small bluefish.
18. Twenty-six men; two gangs.
19. Southeirly and westerly.
20. As far as Reedy Island.

“The fishing-ground is outside of the Capes. There is too much tide inside for purse-fishing. Mackerel sharks are most common, but some sand sharks are seen here. The most common food-fishes caught here are weakfish caught in stake-traps, and shad in nets.”

Answers on board the next one visited:

1. Steamer Samuel S. Brown.
2. Mystic, Conn.
3. James Linen.
4. Yes; take them every pleasant day.
5. Small menhaden.
6. On 10th May; mackerel at Cape Hatteras; menhaden at Cape Henry.
7. Nine miles in twenty-four hours.
8. From 4 to 10 fathoms.
9. Small and large fish do not as a rule run together.
10. Two and a half millions.
11. Four millions.
12. Eight hundred thousand.
13. S. S. Brown & Co.
14. New this season.
15. Length, 160 fathoms.
16. One season.
17. Very few.
18. Twenty-five men; two gangs.

19. Moderate southerly winds.

20. To the head of navigation.

"Our fishing-ground is from Fenwick's Shoal to Hereford light. There are very few fish caught inside Cape Henlopen, the strong tide preventing. Sharks are very numerous and troublesome; they are of the sand and mackerel species. At present, fish are more plentiful than I have seen them for twenty years."

The two menhaden factories at the breakwater are new, having been put up the present season.

On July 10, off Sandy Hook, the following replies were received upon boarding a fisherman, viz:

1. Sloop Mary E.

2. Greenport, N. Y.

3. W. Downs.

4. Yes.

5. Small menhaden.

6. Tenth of May; off Sandy Hook and the Highlands.

7. About 10 miles in 24 hours.

8. From 7 to 9 fathoms.

9. There are no sharks here.

10. Eight hundred thousand.

11. Two million.

12. Four millions.

13. Daniel Vail.

14. Six millions.

15. Length, 150 fathoms; mesh, $2\frac{1}{2}$ inches.

16. One season.

17. None of consequence.

18. Nine men.

19. Southerly and westerly weather.

20. Amboy.

On the same date Captain Almy visited three factories that were in operation at Port Monmouth, N. J. The first one visited was owned by Daniel Vail, who made the following statement, viz:

"We have been in operation one year and employ three gangs. We have caught this year up to date 3,500,000 fish. The total catch last year was 4,000,000. The first fish this season were received on April 24, and were caught in a pound. The first fish caught in a purse seine were taken on the 16th of May. The average amount of oil realized was one gallon to the thousand. The bay fish leave here about the 20th of October. The other fish caught are those working to the southward through the sound. About 50,000 menhaden are used daily for bluefish bait. Very few edible fish are taken with the menhaden. The principal food-fishes taken in this locality are weakfish, bluefish, round mackerel, shad, and butter fish. I have not noticed any scarcity of food-fishes in the last twenty years. I believe that the fish make their

appearance earlier in the spring after a warm winter. Within a radius of 1 mile of this place are four factories in operation. No steamers are employed, sailing gangs being used altogether. I consider westerly winds most favorable for taking fish."

The next one visited was that of Mr. D. F. Vail, whose foreman made the following statement, viz:

"This factory has run continuously for the last sixteen years, employing at present three gangs. We have caught up to date this season about 2,000,000. The total catch last season was 3,000,000. On the 29th of April the first menhaden was caught in traps. On the 17th of May the first one was caught in a purse-seine. The average this year is $1\frac{1}{2}$ gallons of oil to the thousand. We closed last year on the 1st of October. The best fishing is during the months of June and July. The greatest amount of fish ever received was 7,000,000 in a season. Five years ago, fishing was much better than it was last year."

The next one visited was that of Osborn & Sons, whose foreman made the following statement, viz: "This factory has been in operation continuously for four years, employing three sailing gangs, who have caught up to date, this season, one and a half millions of menhaden. The total catch last year was 5,000,000. The first fish this season, caught in a purse-seine, were received at the factory on the 25th of May. The average yield of oil is $1\frac{1}{2}$ gallons to the thousand. Last year we closed on the 10th of November. No fish were caught in this bay after that date. There are more fish of all kinds here this year than have been seen in the last seven years. This statement applies also to the local food-fishes. Southerly and westerly winds are most favorable for catching fish. Northeast winds drive them to sea. After a northeast blow, fish are not caught again until westerly weather prevails. I have noticed three separate runs of fish, viz, one in May, another the latter part of June, and another in September. After a severe winter, shad are not so plenty. Bluefish are more numerous off the Hook this year than for several years past; weakfish are also very numerous.

On the same date, off Fire Island, the following answers were received upon boarding a fisherman, viz:

1. Schooner Mary Woods.
2. New York.
3. Charles Yarrington.
4. Yes.
5. Large menhaden.
6. 15th of May; off Jersey beach.
7. Sometimes 2 miles, sometimes 10.
8. About 7 fathoms.
9. These answers apply to menhaden; know nothing of mackerel.
10. Five hundred thousand.
11. Twenty-four hundred thousand.
12. Five hundred thousand.

13. Smith, Yarrington & Co.
14. Twenty-six hundred thousand.
15. Length, 170 fathoms; mesh, $2\frac{1}{2}$ inches.
16. Two years.
17. Very few; not enough for the crew to eat.
18. Twelve men.

We saw numerous schools of menhaden off Fire Island light, and continued to see them at intervals till dark. The last run was seen off Shinnecock light-house.

The first factory visited on the morning of July 11 was that of the Atlantic and Virginia Fertilizing Company, located at Long Beach, Long Island. The superintendent, S. H. Doran, made the following statement, viz:

"These works have been in operation for twenty-three years, and employ one fishing steamer. We have caught up to date this season 1,050,000 fish. The catch last year was 1,400,000. The first fish was caught in a purse-seine on May 19. The average of oil to a thousand fish is $1\frac{1}{2}$ gallons. They are small fish. We closed last year on the 15th of November. We catch very few edible fish among the menhaden. Southerly and westerly winds are most favorable. Fish scatter apart in warm weather and school together when the weather becomes cooler. Mackerel arrive on the south side of Long Island about the middle of May. We do not catch any mackerel after the 15th of June. The most extensive part of the business done here is the manufacture of fertilizers. The scrap furnishes ammonia, rock phosphate, the phosphate of lime and phosphoric acid when treated with sulphuric acid."

The next one visited was the Peconic Oil Works, Corwin & Cartwright proprietors, located at Shelter Island, Long Island. The foreman, Mr. W. M. Jennings, made the following statement, viz:

"These works have been in constant operation for fifteen years, employing two steamers with single gangs. We have caught up to date this season 3,500,000. We caught last season 7,000,000. We received the first fish this season on the 10th of May; last season, 14th of April; both caught in purse-seines. We average one gallon of oil to the thousand. We received fish on the first day of last December, on which date the factory closed. We notice mackerel among the menhaden the latter part of May, but do not see any after the 1st of July. In the bays, mackerel are not caught among the menhaden. I do not know whether fish spawn here or not. The food-fishes in this locality are sea bass, bluefish, Kingfish, and weakfish, all of which are caught in pounds. The first salmon ever known in these waters was caught in a pound trap this season and weighed 20 pounds. Fish scatter in small schools in warm weather and get together in larger bodies as the weather becomes cooler. At this place we simply dry the scrap in the sun. There are two factories located 5 miles from here at Northwest. They are owned

by Mr. Henry Wells and Messrs. Preston & Raynor, the latter being known as the Sterling Works."

The next one visited was the Neamoug Oil Works, situated at Bunker City, Shelter Island, and owned by Hawkins Bros., who made the following statement, viz:

"These works have been in constant operation for eighteen years, and employ 6 steamers carrying 8 gangs. We have caught up to date 7,000,000 of fish. Last year's catch amounted to 19,000,000. We received the first fish on the 15th of May. The factory closed on the 6th of November. There were some fish here after that date. We do not know anything about mackerel. There are more menhaden this year than have been known for the past three years. Fish have gone farther east than usual this year. We think that the temperature of the water governs them altogether. This firm makes an annual report to Professor Baird at Washington."

On the same date, Captain Almy visited the Novelty Oil Works, located at Promised Land, Napeague Bay, Long Island. The proprietor, Mr. James Smith, made the following statement, viz:

"These works have been in continuous operation since 1879, employing two steamers with single gangs. We have caught up to date this season 2,700,000 fish. Caught last season 7,003,000. Received the first fish on May 16. Closed last year on the 16th of November. The present yield is two gallons of oil to the thousand."

Mr. James Smith also informed us that the factory of E. Tuthill & Co., located near here, corresponded nearly with his own in regard to the number of gangs at work and in most other respects.

Captain Almy remarks that there is one point upon which they all agree, which is the great abundance of fish. Those who have been longest in the business contend that if fish are not in this locality they are in some other; that they go where their food is most abundant in the same manner as do other fishes; and that their natural enemies destroy thousands where men with all their modern appliances catch one.

On the same date, July 11, the Excelsior Oil Works located upon Hicks Island, Promised Land, Napeague Bay, was visited. The superintendent, Mr. O. H. Bishop, made the following statement, viz:

"These works have been running four years, employing two steamers, each carrying one gang. We have caught this season up to date 2,100,000 fish. Last year's catch was 6,300,000. The first fish was caught in a purse-seine on May 19. Last year these works closed upon the 23d day of November, and we received fish up to that date, the biggest catch of the season being on that day. The yield of oil so far this season has been 1 gallon to the 1,000. I believe that some grades of these fish are spawning constantly every month that they are on this coast. Fish do not show in schools until the temperature of the water is about 54° Fahr. There are more fish here this season than have been

seen for the past four years. The principal food-fish in this locality are weak-fish, butterfish, scup, and bluefish, the latter species being very numerous this year. Menhaden have gone farther east this year than for the past four years."

There are five factories now in operation in this vicinity, which is a very central location for fishing.

On the same date the factory of the Montauk Oil Company, located at Promised Land, Napeague Bay, Long Island, was visited. The superintendent made the following statement, viz:

"We have been running for four years, employing three steamers carrying four gangs. Caught this season up to date 7,000,000 fish. Last year's catch was 13,500,000, working three gangs. The first fish this season were taken on the 18th of May. These works were closed last year on the 5th of November. The present yield is less than a gallon of oil to the 1,000. Fish are more plentiful this season than they have been for the past four years."

The next one visited was the Falcon Oil Works, located at Promised Land, Napeague Bay, Long Island, George E. Tuthill & Co., proprietors. Mr. Tuthill made the following statement, viz:

"These works have been in operation for twenty years, employing 2 steamers with four gangs and one sailing gang. We have caught up to date 6,000,600 fish in purse-seines and 5,400 in pounds. Last year's catch was 11,500,000. Our first fish this season were taken on the 29th of May. These works were closed last season on the 10th of November. At present the yield of oil to the thousand is $1\frac{1}{2}$ gallons."

The next one visited was the Dixon Oil and Guano Company's Works, in the same locality. Mr. Hiram R. Dixon, owner and operator, made the following statement, viz:

"I have been in business for four years, employing three steamers carrying four gangs. Have received this season up to date 1,509,390 fish (equal to 5,135 barrels). Last year's catch was 1,451,184 fish (equal to 4,936 barrels). The first fish this season were received at the factory on the 25th of May. This factory was closed last year on the 7th of November. The yield of oil is 2 quarts to the barrel of fish."

The next one visited was that of the Ranger Oil Company, in the same locality, Thomas T. Price, David G. Floyd, and John L. Lawrence, proprietors. The superintendent made the following statement, viz:

"These works have been in operation for fifteen years, employing three steamers carrying four seines and one sailing gang. We have caught up to date this season 5,000,000 fish. Last year's catch was 9,700,000. The first fish were received on the 12th of last May. These works were closed last year on the 17th of November. At present the average yield of oil is two gallons to the thousand. The yield of oil last season was 1,857 barrels."

The first factory visited on the morning of July 12 was that of E.

R. Kelsey, situated at Branford, Conn. He made the following statement viz :

"This factory has been in operation for fifteen years. We catch fish in pounds, and do not use purse-seines. We do not use steam like the other factories, but cook the fish by dry heat in large iron tanks set over coal fires. We fish 3 pounds, and have caught up to date this season 2,000,000 fish. Last year's catch amounted to 1,500,000. We received the first fish on May 14. We closed last year on September 20. I do not know where menhaden winter nor what they eat; have no idea what effect change of temperature of water or air has upon them. Their arrival and departure is very much affected by the temperature of the water. I cannot suggest any improvement over the present method of taking menhaden. If I knew of one, I should adopt it."

The next factory visited was that of George W. Miles, located at Milford, Conn. He made the following statement, viz :

"This factory has been in operation for nineteen years. We employ at present three steamers, carrying four gangs and two sailing gangs. We have caught this season up to date 10,000,000; last years catch was 20,000,000. Received the first fish on May 15; last fish last season on November 15. The average of oil to the thousand fish is 3 gallons. We press the fish three times. The best months for fishing are July and August. The greatest amount of fish we have taken is one season was 38,000,000. We make complete fertilizers for all farm crops, and have large quantities of rock phosphate on hand. I do not know where menhaden winter nor what they eat. The temperature of 54° Fahr. is considered best for fish to show in. Their arrival and departure is affected by the temperature of the water. If we knew of any better way of taking fish we should adopt it. The purse-seine is at present the best contrivance we know of for catching all fish that come to the surface in schools."

On July 13, off Cedar Point, Connecticut, Captain Almy boarded a fishing steamer, and asking the same questions as before, received the following replies, viz :

1. Steamer Montauk.
2. Geenport, Long Island.
3. John W. Burns.
4. Yes.
5. Small menhaden.
6. 10th of May; off the coast of New Jersey.
7. Four miles per hour.
10. Three millions.
11. Three millions.
15. Length, 160 fathoms; mesh, 2½ inches.
18. Twenty-five men; two gangs.
19. Southerly and westerly winds.

20. The whole length of Long Island.
21. I do not know where they winter.
22. They feed on brit and a kind of jelly on the surface of the water.
23. Fish in the sound do not show during a cold north wind. They do not show in the spring until the temperature of the water reaches 52° F.

25. I can suggest faster boats as the only improvement.

Answers on board the next fishing steamer at the same place:

1. William A. Wells.
2. Greenport, Long Island.
3. W. G. Bailey.
4. Yes.
5. Very small menhaden.
6. I first saw them on the south side of Long Island.
10. Eleven hundred thousand.
11. Twenty-four hundred thousand.
21. I believe that they winter on the coast of Florida.
24. I think it is.
25. Faster boats would be a great improvement. Last year, mackerel were quite numerous; this year we have seen very few. I think that if no menhaden were caught when they first appear on the coast until about the 10th of June, they would come in the bays where they spawn. I believe it would be better for all if a law were passed prohibiting menhaden fishing until the 15th of June.

Answers on board the next fishing steamer off Cedar Point, Connecticut, July 13, 1883:

1. Steamer Portland.
2. Port Jefferson.
3. M. J. Morran.
4. Yes.
5. Small menhaden.
6. The first mackerel are usually caught between Capes Hatteras and Henry, about the middle of April. We caught the first menhaden off Long Branch, N. J., on May 14.
7. Fish making a passage usually travel about two miles an hour.
8. Caught in all depths.
10. Fifteen hundred thousand.
11. Four million four hundred and five thousand seven hundred.
15. Length, 220 fathoms; mesh, $2\frac{3}{4}$ inches.
17. Very few; occasionally bluefish.
20. The whole length of the sound.
21. We think on the coast of Florida or western edge of the Gulf.
22. Do not know.
23. They scatter in warm weather and come together in cooler weather.
24. Yes.

25. I believe that steam launches could be used to set seines out.

On July 13 Captain Almy visited the factory of Luce Brothers, whose foreman made the following statement, viz:

"This factory has been in operation twenty-three years, employing three steamers, carrying four gangs. We have caught up to date this season 5,312,000 fish; caught last year 13,000,000. Received the first fish this season on May 14. Closed last year on the 16th of November. The last fish was taken on that date. The average of oil to the thousand fish is 2 gallons at present. We catch very few edible fish with menhaden. Very few fish are caught after the water is colder than 52° Fahr. We rig our seines deeper for outside fishing than for fishing in the bays. The principal edible fish in this neighborhood are tautog, flounders, small mackerel, bluefish, weakfish, and cunners. Eels are very plenty. No large mackerel ever come here. We get the most fish during calm weather. The largest catch ever known at this factory in one season was 29,000,000. Fish were much fatter last season than this. More fish have been reported on this coast this season than have been known before for three or four years."

We left port again at 3 p. m. July 16, with a number of naturalists on board, for an off-shore trip. The weather was calm and clear, with smooth sea. Several swordfish were sighted off No Man's Land, and the steam cutter lowered for one, but failed to get it.

At 9 a. m. the following day we cast the lead in 1,346 fathoms, latitude 39° 27' 10'' N., longitude 69° 56' 20'' W., and put the trawl over. We made another haul in 1,362 fathoms, latitude 39° 26' 16'' N., longitude 70° 02' 37'' W. Both hauls were successful. We also took a set of serial temperatures and water specimens from the surface to 1,000 fathoms.

The last haul was finished about 10 p. m., when the vessel was headed to the southward, and at daylight the following morning we cast the lead in 1,735 fathoms, latitude 38° 52' 40'' N., longitude 69° 24' 40'' W., and put the trawl over. Another haul was made during the day in 1,731 fathoms, latitude 38° 53' N., longitude 69° 23' 30'' W. Several new species were found both yesterday and to-day. A set of serial temperatures and water specimens was taken from the surface to 1,600 fathoms. Bottom temperatures were observed also, and a water specimen taken from 1,731 fathoms. The last haul was finished at 9 p. m., when we started for port.

The weather continued pleasant and the sea smooth. The dredging apparatus worked well, but the blocks are wearing rapidly and will require repairs. The arc light was used for night work and answered the purpose admirably, the naturalists finding no difficulty in picking over the contents of the trawl and carrying on the usual work on deck. There were two Negretti-Zambra thermometers lost during the trip and about 300 fathoms of heavy sounding wire used on the small sounding machine

for taking serial temperatures. We arrived in port at 3 p. m., and anchored in Great Harbor.

At 12.35 p. m. July 20 we left Wood's Holl for Newport, R. I., for coal, arriving at 4.30 p. m. We received on board 100 tons, and at 12.20 p. m. on the 24th left for Wood's Holl, arriving at 4.55 p. m.

At 3.15 p. m. on the 25th we left port for an off-shore dredging trip. The weather was clear and pleasant, with light southerly winds. At 2.35 p. m. the following day we got soundings in 2,033 fathoms, latitude $38^{\circ} 30' 30''$ N., longitude $69^{\circ} 08' 25''$ W. The wire parted while reeling in, and we lost the specimen cup, thermometer, and 92 fathoms wire. The trawl was lowered and brought up a bottom specimen, which proved to be globigerina ooze. The haul was successful although the quantity of material was quite small. There was no attempt at rapid work, two hours and eighteen minutes having been spent in veering 2,700 fathoms of dredge rope and landing the trawl on the bottom. It was hove up in one hour and fifty-five minutes.

At 5.58 the following morning we cast the lead in 2,451 fathoms, bottom globigerina ooze, latitude $37^{\circ} 58' 30''$ N., longitude $69^{\circ} 01' 20''$ W., and commenced taking a set of serial temperatures and water specimens, when, in slacking away the forward boom-guy, it was accidentally let go and the boom flew aft, violently striking the fore-rigging with sufficient force to break it at the heel where it entered the metal socket. The rope was hove in, the boom repaired, and at sundown we were in working order again.

Our method of taking serial temperatures and water specimens is as follows, viz: A cast-iron sinker weighing 500 pounds is shackled to the dredge rope, a few fathoms veered out, and a Sigsbee water cup and Negretti-Zambra deep-sea thermometer secured to it. The rope is then veered rapidly and the instruments secured at the desired intervals until the series is complete. The necessary time being allowed for the thermometers to take the temperature, the rope is hove in at any desired speed and the instruments taken off as they come up. The above method is generally used for 100 fathoms and upwards, the Tanner sounding machine being utilized to complete the series to the surface.

There was a brisk breeze and considerable swell during the day, but the wind moderated during the evening and the sea went down. We hung the arc (electric) light over the side after dark and kept it there about two hours. A small school of squid was attracted by it, and several small fish were seen near the ship, although it is not certain that they were attracted by the light. Several petrels were dazzled by it and fell on board, where they were captured for specimens.

At 4.33 a. m. on the 28th, we sounded in 2,976 fathoms, globigerina ooze—latitude $37^{\circ} 54' 49''$ N., longitude $68^{\circ} 05' 25''$ W. This depth was unexpected, and as there was some doubt as to the accuracy of the sounding, it was repeated, 2,900 fathoms of wire allowed to run out, and then an attempt made to reel in, but the sinker had not reached bottom and

was still attached. This extra weight being put upon the wire, it soon parted at 825 fathoms. We lost the specimen cup and thermometer. The result of this sounding was a surprise, and indicated the extension of the 3,000-fathom hole much to the eastward of its supposed limit. We did not intend to work in over 2,400 fathoms during the trip, and were not prepared for a depth of nearly 3,000, having but 3,400 fathoms of dredge rope on the reel.

At 11.54 a. m. we sounded in 2,369 fathoms, globigerina ooze—latitude $38^{\circ} 19' 26''$ N., longitude $68^{\circ} 20' 20''$ W. The wire kinked and parted at $19\frac{1}{2}$ fathoms while reeling in. The specimen cup and thermometer were lost. The deep-sea trawl was put over at 1.03 p. m., and at 4.03 p. m. it was on the bottom, 3,200 fathoms of rope having been paid out. At 5.50 we commenced heaving in, and at 8.15 the trawl was up. The haul was successful, many new and interesting forms having been brought up. After the trawl was up, we took a set of serial temperatures and water specimens to 1,000 fathoms.

On July 29 there was a moderate to brisk breeze from southwest to northwest, and moderate swell; passing squalls. At 4.20 a. m. we sounded in 2,226 fathoms, globigerina ooze—latitude $38^{\circ} 35' 13''$ N., longitude $68^{\circ} 16'$ W. At 5.57 put the deep-sea trawl over; at 8.28 trawl down, having veered 3,000 fathoms of rope. Commenced heaving in at 11.05, and at 1.38 p. m. the trawl was up. The haul was successful, although many small specimens were washed through the meshes of the net by the motion of the vessel in the lumpy sea. After the trawl was up, we steamed to the northward about sixty miles to get shoaler water.

At 3.15 a. m. on the 30th we sounded in 1,608 fathoms, globigerina ooze, and put the deep-sea trawl over—latitude $39^{\circ} 22' 50''$ N., longitude $68^{\circ} 25'$ W. At 10.31, sounded in 1,555 fathoms, globigerina ooze, and put the deep-sea trawl over in latitude $39^{\circ} 33'$ N., longitude $68^{\circ} 26' 45'$ W.; at 5.07 p. m. cast the lead in 1,467 fathoms, the character of the bottom the same, and put the deep-sea trawl over in latitude $39^{\circ} 49'$ N., longitude $68^{\circ} 28' 30''$ W. The three hauls made during the day were very successful, many new and interesting specimens having been obtained.

Five hauls of the trawl were made on the 31st, in from 1,067 to 373 fathoms, between latitude $40^{\circ} 00' 30''$ N., longitude $68^{\circ} 37' 20''$ W., and latitude $40^{\circ} 02'$ N., longitude $68^{\circ} 50' 30''$ W. We lost a trawl net during the day; with this exception the hauls were successful. After the last haul a set of serial temperatures and water specimens were taken to 500 fathoms.

On August 1 there was clear, pleasant weather and smooth sea. Four hauls of the trawl were taken during the day in from 1,025 to 1,106 fathoms between latitude $39^{\circ} 43' 40''$ N., longitude $69^{\circ} 20''$ W., and latitude $39^{\circ} 40'$ N., longitude $69^{\circ} 21' 25''$ W. During the first haul, while heaving up the trawl, the rope parted; the trawl, wings, and 2 or 3

fathoms of rope were lost. The rope parted at a kink. With the above exception the hauls were very successful. At 10.20 p. m. we started for Wood's Holl, arriving at 2.05 p. m. the following day, when the specimens were transferred to the laboratory.

At 11 a. m. on the 6th we left for Newport, where we arrived at 6 p. m. and anchored for the night. At 9 a. m. the following day we got under way and proceeded to sea for the purpose of ascertaining the present location of menhaden and other schooling fish in the waters adjacent to Block Island, Montauk, and the southern coast of Long Island. The weather was clear and calm, the glassy surface of the sea enabling us to discover the smallest ripple at any distance within the line of vision. A lookout was kept both on the bridge and at the mast-head. We stood directly for Block Island and, passing it on the starboard hand, ran 11 miles SSW. $\frac{1}{2}$ W., then 9 miles NNW. 25 miles S. by W., then 26 miles N. $\frac{1}{4}$ W. which brought us inside of Montauk Point, where at 7.10 p. m. we anchored for the night. There were no schooling fish seen during the day. We were under way again at 4.30 a. m. the following day, and stood along the southern shore of Long Island from 3 to 5 miles from land until off Shinnecock light, but no fish were seen. We then turned off shore S. by E. and soon saw small schools of menhaden, and at 9 miles from land saw large schools extending about 7 miles. Reaching a point 20 miles S. by E. of Shinnecock, we changed the course to ENE. $\frac{3}{4}$ E. and ran 60 miles. After steaming about 18 miles on the above course, large schools of menhaden were seen, and we continued to pass them for nearly an hour. Schools of small mackerel, porpoises, and an occasional sword-fish were seen during the day, but no more menhaden. Having brought Block Island to bear NW. by N. 23 miles distant, we ran for it, anchoring at 6.50 p. m. off the basin.

At 5 a. m. the following day we got under way and ran 33 miles SE. by E., 25 miles E. by S., 15 miles NNE. $\frac{3}{4}$ E. to within 6 miles of the south coast of Nantucket, then 18 miles NW. by W. $\frac{1}{2}$ W. and 10 miles W. to No Man's Land, which we rounded within a mile or two of the land and stood for Gay Head, where at 6 p. m. we anchored for the night. A few small schools of menhaden were seen soon after leaving Block Island. Small mackerel were encountered at intervals throughout the day, and quite a large number of sword-fish were seen also. We were under way again at 6 a. m. on the 10th, and ran SW. by W. 20 miles, then laid a course direct for Newport, where we arrived at 10.52 a. m.

I would call your attention to the statement of Captain Tuttle, in Captain Almy's report, in which he says that codfish caught winter before last between Barnegat and Fire Island were found to have menhaden in their stomachs. I would also call your attention to Mr. Nicholas Ball's statement that codfish arriving on the Block Island grounds

about the 1st of April have spawn in them, but have none when they return in October.

The following is the report of Captain Jacob Almy, fisherman expert, viz:

On Sunday, August 6, I interviewed Mr. Church and Messrs. Brown & Brightman, the only two firms doing business in Narragansett Bay. Mr. Church made the following statement: "Mackerel and menhaden make their appearance on this coast about the same time, from the 1st to the middle of May. The menhaden coming first travel much faster than those appearing afterwards. They are caught from the shore to 30 miles at sea. Our last year's catch by 8 gangs was 140,000 barrels. The average of oil to the barrel of fish was $1\frac{3}{4}$ gallons. Our entire catch this year to date is 90,000 barrels. The average yield of oil this year is $\frac{2}{3}$ of a gallon to the barrel of fish. I believe that menhaden do not spawn until the months of December and January; when leaving here they are full of spawn. I believe it would be safe to offer one dollar each for every menhaden found in the spring containing ripe spawn."

Messrs. Brown & Brightman stated as follows:

"We have caught up to date this year 39,000 barrels of menhaden with an average of $\frac{2}{3}$ of a gallon of oil to the barrel of fish. Last year's catch was 23,000 barrels with an average of $1\frac{3}{4}$ gallons of oil to the barrel.

We use seines 200 fathoms long with $2\frac{1}{4}$ to $2\frac{5}{8}$ inch mesh, which only last one year. We employ twelve men to a seine and run five gangs. I believe that the food-fishes caught with the menhaden would not be enough to supply the men taking them with fresh fish to eat. Warm southerly winds are the best for taking menhaden. I believe that very few if any of these fish spawn here. They have large spawn in them when they leave here in the fall, and have none when they return in the spring. We have no idea what they eat, but believe that they feed sometimes from the bottom and sometimes from the surface. We cannot suggest any better method of taking them."

This vessel left Newport on the morning of the 7th instant, and proceeded to sea. At 9.45 Brenton's Reef bore abeam, course SW. $\frac{1}{2}$ W. We saw between Point Judith and Block Island a fishing steamer standing to the eastward, probably making for New Bedford. At 12.30 p. m. changed course to NNW. and ran $9\frac{1}{2}$ miles, then to S. by W. and ran 24 miles, then to N. $\frac{1}{2}$ W. and at sunset anchored off Montauk Point. We saw two fishing steamers off the point. After anchoring I boarded two smacks engaged in taking sea bass.

Capt. A. H. Tuttle, of the vessel Louise, from Greenport, made the following statement:

"I have formerly been engaged in the menhaden business. They come to the coast from the 15th of April to the 10th of May. The first fish that make their appearance are usually larger than those which follow. The second run are those which stop and school in the bays and inland waters. Their food is a very small marine insect, which appears

under the microscope to be a species of crab. During the winter before last all the codfish caught from Barnegat to Fire Island were found to have menhaden in their stomachs, proving that there were menhaden on that ground all winter. They do not strike the coast at some southern point and work along northward, as some suppose, but come to it directly from the sea, although after reaching it their course is to the northward. I have noticed that very few menhaden spawn in this locality and very little ripe spawn at any time in the fish that come here. About August 1 they come out of Long Island Sound and go to sea, continuing to do so until snow falls in the autumn. Usually schools of mackerel come here about June 15, and make a short stop before going east. Menhaden, when traveling, will sometimes school and show on the surface if the weather is cold, but feeding fish do not show unless the weather is warm."

Capt. D. Racket, of the smack *Georgeanna*, from Greenport, engaged in taking sea bass, made the following statement:

"I have seen menhaden nearly every day in the neighborhood of Montauk Point. Hook-fishing, as a general thing, has been good this year. I consider 150 fish to each man per day a fair average."

On the 8th we got under way and stood to the westward along the southern shore of Long Island. We saw a number of small schools of menhaden off Shinnecock, the light bearing abeam about 4 miles distant. At this point changed course to S. by E., and 9 miles from Shinnecock saw large rafts of menhaden considerably strung out and in sight in all directions. We saw them first at 8.45 a. m., and passed the last at 9.30 a. m., the vessel then making 9 knots. No fishing gangs were in sight. It was nearly calm, with very light airs from the westward. Off shore of these fish we saw numerous "puffing pigs" and one swordfish. Eighteen miles on this course we saw a school of small mackerel. Tide rips here have a very peculiar appearance, and strongly resemble mackerel schooling. At 10.40 a. m., Shinnecock light being 21 miles to the northward and westward, the course was changed to ENE. $\frac{3}{4}$ E. At noon saw several schools of menhaden, and continued to see them until 1 p. m. At 3.30 saw a very large school of porpoises, Block Island bearing abeam about 15 miles distant. Anchored off the basin, Block Island, for the night. After anchoring I went on shore and interviewed Mr. Nicholas Ball, one of the oldest residents of the place, who made the following statement:

"The net profits of the fisheries of this island for the year 1882 amounted to \$42,325. This money was mostly realized from the sale of salt fish and oil. Codfish arrive here about the 1st of April, and are caught until the first of June, when they disappear. They have spawn in them when they arrive in the spring, but when they return, about the middle of October, they have none. They usually remain here in the fall until the latter part of December. Mackerel arrive here about June 1; they make a very short stop, seldom longer than two

weeks. Menhaden do not make any stop here, but are frequently seen making passages. Bluefish arrive about the middle of June, and, like scup and weakfish, are a local fish at this season of the year. There are some fish in the different ponds on the island, and good oysters are obtained if the entrance to the large pond is kept open. About 350 men are engaged in the fisheries at this place."

At 5 a. m. on the 9th instant we got under way and set course SE. $\frac{1}{2}$ S. We saw three small bunches of fish near the island. Twelve miles on this course we saw a school of small mackerel, and a short distance farther on another school. I am certain that they were mackerel, for some large fish were feeding upon them, causing them to jump entirely out of the water so that they could be plainly seen with a glass. At 9 a. m. changed course to E. by S. At 9.45 we saw another school of small mackerel. Swordfish were seen at short intervals during the day; I counted 16 from the deck of the ship. The dinghy was lowered and we tried for an hour to catch one, but, the conditions not being favorable, did not succeed. The weather was very mild, with light breeze from the eastward all day. At 2 p. m. we saw two schools of small mackerel 7 miles south of Nantucket Island, and at 3 o'clock, the ship running to the westward, saw another. Anchored just before sunset inside Gay Head. I visited the shore, but could not obtain any information, although the people here live principally by the occupation of fishing.

At 6 a. m., on the 10th got under way and stood SW. $\frac{3}{4}$ S. for 20 miles, then NNW., and at 11 a. m. anchored in Newport Harbor. We did not see fish of any kind on the passage; saw one menhaden steamer bound to the southward.

We left Wood's Holl at 1.40 p. m., on the 20th instant, in search of mackerel in the regions about Nantucket, George's Bank, Cape Sable, Grand Manan, &c. After passing Gay Head and No Man's Land, a course was laid for South Shoal light-ship, but a fog came on before we reached it, narrowing our vision so much that I concluded to lay to until it lighted up. We saw no fish during the day. At 4.30. the following morning the fog cleared away and we started for George's Bank. Passing to the northward of Cultivator Shoal we then ran through the passage between it and George's. The fog came on again soon after we cleared the passage, and not wishing to pass over any ground in this vicinity without a thorough search, we stood off and on during the night under low speed, and at daylight, the following morning, resumed our course around the bank in from 30 to 40 fathoms of water; then ran across to Cashes' Ledge; thence to Brown's Bank, where we arrived on the morning of the 23d; ran over its entire length from north to south; then stood for the coast of Nova Scotia, sighting Seal Island light during the evening, and soon after crossing German Bank. The weather was squally during the night, with passing showers, but cleared in the morning. At 5.40 a. m., on the 24th, sighted Gannet Rock light at the entrance to the Bay of Fundy, crossed the Grand Manan Bank, and

stood for Mount Desert rock, where we came up with the mackerel fleet about 2 p. m. One hundred and thirty-five schooners were in sight at one time. We saw no schooling fish during the trip, and the fishing vessels spoken on George's and Brown's Banks had neither seen nor heard of any in that region during the season. They had appeared on Grand Manan for three days about a month since. The fleet were cruising between Mount Desert Rock and Jeffrey's Bank, but were meeting with poor success. Having passed the fleet, we stood for Jeffrey's Bank, Platt's Bank, Jeffrey's Ledge, and thence to Portsmouth, N. H., where we arrived at 9 a. m. on the 25th.

Capt. Jacob Almy, fisherman expert, reports as follows:

"We left Wood's Holl on August 20, and passed out of Vineyard Sound to the southward; at 3 p. m. Gay Head bore abeam. Did not see any surface fish in the sound. Passed six smacks engaged in taking bluefish. There was a fresh breeze from the southwest. At 4 p. m. No Man's Land bore abeam. As night came on and the weather became foggy, we stopped the engines and lay to until morning. At 8.30 on the morning of the 21st, the fog lifted, with moderate breeze from the southwest. Saw this morning one whale of the hump-back species, the first sign of marine life seen since leaving port. At noon saw a school of porpoises. Passed one fishing vessel at anchor and several under way, supposed to be engaged in the cod fishery. At 2.30 p. m. saw two fin-back whales. At 3 changed course and passed between Cultivator and George's Shoals. Saw a fisherman running to the eastward. Towards sunset we were enveloped in a dense fog, which cleared away about 9 p. m.

The morning of the 22d was clear and pleasant, wind from NW. We are bound to the northward along the eastern edge of George's Bank. The tide rips around these shoals are very peculiar in appearance and would generally be taken for breakers in shoal water. Saw only one school of porpoises and one swordfish during the day. Saw two fishing vessels in the afternoon, one of which, the *Anna H. Mason*, of Gloucester, Mass., was visited. Capt. Joseph Lyle stated as follows:

"I struck fish this morning, although I have been two days on the bank; have about 100 fish on deck. Codfish are local here, and can be caught in any month of the year. They go in schools on the bottom and never appear on the surface. They spawn here in January and do not take the hook while that season lasts. The reason, I believe, that they do not feed while spawning is that they are easily caught in nets when they will not touch a hook. The male fish are larger than the female. Consider the practice of throwing gurry overboard on fishing ground injurious. Vessels anchoring to windward and throwing overboard their offal spoil the fishing for vessels to leeward. Vessels engaged in bank fishing are generally worked with the agreement that the vessel and outfit take half, and the crew the other half of the proceeds. Eight men constitute a crew. There are no officers except the

captain. A trip usually lasts about three weeks, from four to six tons of ice being required to preserve the catch. I consider a vessel of this size to be worth about \$12,000. There are many more vessels engaged in this business at present than there were six years ago. We save from all fish the livers: from cod, the sounds and tongues. We clean and dry the sounds taken from hake, which are used for a different purpose than those taken from cod. Other varieties of fish, such as haddock, cusk, halibut, pollock, &c., are taken on all parts of this bank while fishing for cod, and almost all other varieties known in our waters are plenty here at certain seasons of the year."

The morning of the 23d was clear and pleasant. At 2 p. m., while on Brown's Bank, we saw a school of porpoises and a grampus. We saw a number of fishing vessels, but none near enough to speak without going out of our course. All were under way trying the bottom for fish. At 5.56 p. m. boarded the schooner Lydia Ryder, of Pubnico, Nova Scotia, which was then taking fish. The captain made the following statement:

"We have been out 8 days and have taken 1,000 pounds of codfish, which are salted in our hold in bulk. We use for bait herring, mackerel, and squid, which are caught in nets at the port from which we sailed. I have not seen any mackerel for the last month; think that most of them are at present around the Magdalen Islands, as I have seen a number of vessels bound in that direction. Mackerel come to our place about the middle of May and leave about the last of June. Menhaden never come to our shores. We prepare our own fish, which, when ready for market, bring from four to five dollars per quintal. About the average stock for a vessel of this class for four months is \$5,000. These vessels are used to carry freight during the rest of the year. We have no other officers save a captain. We fish altogether off from the vessel with hand lines. The vessel pays for one-third of the outfit, and takes one-third of the catch. The crew find their own provisions, pay the cook, furnish their own lines and hooks, two-thirds of the salt, barrels, &c., and take the other two-thirds of the fish. We found fish the first day we came on the bank. Our bait will hardly last fresh ten days on ice. There are 25 sail on the bank in this business. We catch, besides cod, haddock, halibut, cusk, and other varieties of food-fishes, besides many kinds of trash fishes."

On the morning of the 24th, I boarded the schooner T. W. L. Geser, of Westport, Nova Scotia, on Grand Manan Bank. Capt. E. M. Peters made the following statement:

"Fish are very scarce. I have been out from home fourteen days and have caught 80 quintals of codfish, which are salted in bulk in the hold. I have not seen any mackerel this trip, but last trip, four weeks ago, saw a great many, which were schooling in all directions for three days together. This vessel uses trawls, which are set from dories, of which she carries three, two men going in each. On the 20th of last June I lost one dory, with two men. They went out to set their trawl,

when a sudden fog, accompanied by a strong breeze, came up, and I saw no more of them.

"Last spring trap-fishing for mackerel at Westport, Nova Scotia, was very good. I realized \$4,000 from one trap."

Leaving this vessel, we started ahead. At 9.30 saw numerous porpoises. At 1 p. m. sighted, off Mount Desert Rock, the mackerel fleet, about 150 in number. At 3 p. m. boarded the schooner Nannie E. Waterman, of Wellfleet, Mass. Capt. D. T. Pierce stated as follows:

"We have been out from home fifteen days and have caught 20 barrels of mackerel. The largest catch I have heard of, taken by any one vessel, was 185 barrels. All the mackerel I know of have been seen between Cashes' Ledge and Mount Desert. The last fish I have heard of was caught three days ago. A large majority of the vessels of the fleet have caught nothing this trip. The fish caught are small, the proportion of large ones being about a quarter.

"Mackerel first strike this coast in the spring, about the 25th of March, about 60 miles outside of Cape Henry, and arrive on Cashes' Ledge about the 25th of June. The last fish are taken in Boston Bay about the 10th of November. I never knew of any being caught in the winter. I never knew them to fail to come for the last twenty years. Schools at this season of the year are mixed, the large and small ones running together. I do not think that there is any scarcity of fish; they are always in abundance on some sections of our coast at certain seasons of the year. I do not think that anything that man can do can affects their abundance. Seven years ago they were plenty; the next year, scarce. Their food consists in part of what is known among fishermen as 'cayenne,' only seen when the water is very smooth. It then appears to skip out of the water. It is too small to be seen readily with the eye, but when taken from the stomach looks like pepper, and seems to burn the intestines after the fish is dead."

I told him what we had done for the benefit of the mackerel fleet, and described the course we had taken, its object, &c., which he promised to communicate to the rest.

Having taken on board a supply of coal and provisions, we left the navy-yard at 2.45 p. m., August 28, and proceeded to sea. The weather was pleasant, with light airs from southeast, but the wind increased during the night, and at daylight the following morning was blowing a fresh breeze from northeast.

Two hauls of the dredge were made in 105 fathoms on the northern part of George's Bank, after which we were obliged to cease work and lay to, as it was blowing a moderate gale, with heavy seas. The vessel while hove-to drifted rapidly to the westward, and at 2 a. m. on the 30th we fell in with large bodies of mackerel about 10 miles E. by S. from Cashes' Ledge. The wind moderated during the night and we steamed slowly to the eastward again. At 9.24 a. m. we cast the dredge in 99 fathoms, latitude $42^{\circ} 32' N.$, longitude $68^{\circ} 17' W.$ Four hauls of the

dredge and trawl were made during the day, notwithstanding the heavy swell and fresh winds, and in the evening a set of serial temperatures and water specimens was taken. We were working to the eastward, gradually approaching shoal water on the northern side of George's Bank, the last haul being in 35 fathoms.

We steamed slowly to the eastward during the night, and at 5 a. m. on the 31st cast the trawl in 41 fathoms, latitude $42^{\circ} 05' N.$, longitude $66^{\circ} 46' 15'' W.$ Seven hauls of the dredge and trawl were made during the day between George's and Brown's Banks in from 41 to 150 fathoms. Light to moderate winds from north to east prevailed, with moderate sea. A thick fog set in during the night, clearing away before noon of September 1. A fresh breeze sprung up later in the day, with cloudy, rainy weather. Six hauls of the dredge, tangles, grapnels, and trawl were taken, in from 65 to 131 fathoms, along the west slope of Brown's Bank, and a set of serial temperatures and water specimens was taken in the evening.

A strong wind from the eastward forced us to cease work earlier than we would otherwise have done, and, laying to with the ship's head to the southward, we drifted rapidly to the westward, reaching at midnight a depth of 55 fathoms on the east end of George's Bank. We then steamed slowly to the eastward, and, the wind having moderated, at 6.15 a. m., September 2, we cast the trawl in 858 fathoms, latitude $41^{\circ} 53' N.$, longitude $65^{\circ} 35' W.$ This haul was very successful, bringing up an enormous load of mud, small stones, and marine life. The trawl was lowered again at 11.15 a. m., and we commenced heaving up at 12.50 p. m. The wind had increased to a fresh breeze from southwest by this time, getting up an uncomfortable swell. There was another heavy load in the trawl, and, being anxious to get it on board, we took every precaution in hoisting; but the weight and rapidly increasing sea proved too much for the dredge rope, which parted at a kink 39 fathoms from the end, the trawl and that length of rope being lost. Wind and sea were now too heavy to admit of using the trawl with safety and as soon as the rope was in we steamed to the southward about 10 miles and hove to under the fore staysail, wind and sea one point abaft the beam, the Albatross's favorite position, in which she rides the seas with remarkable ease. At 6.20 p. m., latitude $41^{\circ} 45' N.$, longitude $65^{\circ} 34' W.$, saw a large school of mackerel. We were on the northern verge of the Gulf Stream, the temperature of the water being $69^{\circ} F.$ The wind veered to west during the evening and moderated.

The weather was clear and pleasant on the morning of the 3d, clouding up during the forenoon, and at 11 a. m. a heavy rain squall passed over the ship. The wind was from the westward early in the day, backing to SW. in the squall above mentioned, veering to WSW. and NW. after noon, and increasing to a fresh breeze, with heavy swell. At 8.14 a. m. cast the small trawl in 1,309 fathoms, latitude $41^{\circ} 43' N.$, longitude $65^{\circ} 21' 50'' W.$, and veered to 1,800 fathoms of rope. The trawl

was down at 9.37; began heaving up at 10.50, and it was on board at 11.56 a. m. In addition to numerous interesting forms of marine life, we brought up about 1,000 pounds weight of stones from 6 to 10 inches in diameter. At 2 p. m., passed a ship's boat, keel up. At 4.18 p. m. the trawl was lowered in 855 fathoms, latitude $41^{\circ} 40' 30''$ N., longitude $65^{\circ} 35'$ W. It was on the bottom at 5.10, with 1,300 fathoms of line out. Commenced heaving up at 6.02, and at 6.50 it was on deck. We then ran 5 miles WNW., and cast the lead in 810 fathoms, intending to put the trawl over, but wind and sea had increased so much that it was not considered prudent.

The two hauls taken to-day were practically in the channel between Brown's and George's Banks, although somewhat to the southward of the former. We steamed slowly to the southward and westward during the night and, at 5.13 a. m. on the 4th put the trawl over in 906 fathoms, latitude $41^{\circ} 13'$ N., longitude $66^{\circ} 00' 50''$ W. Seven hauls were taken during the day in from 1,255 to 49 fathoms on the southeast part of George's Bank. The weather was clear and pleasant, with light north-west wind during the morning, backing to the southward in the evening. The last hauls were taken after dark, by the aid of the arc light, which was kept burning half an hour after we finished dredging for the purpose of attracting some of the numerous petrels flying about the ship, but they did not seem to mind it in the least. At 9 p. m. stood to the southward and westward, and at 5.10 a. m. cast the trawl in 959 fathoms, latitude $40^{\circ} 26' 40''$ N., longitude $67^{\circ} 05' 15''$ W. At 9.45 a. m. the trawl was lowered again, 10 miles south of the former position, in 1,290 fathoms, and was up at 1.27 p. m., with an enormous load of mud, and many valuable specimens.

The bottom on the north part of George's Bank was sand, gravel, and stones. In the channel between George's and Brown's Banks, stones were encountered at every haul; even to the southward of Brown's Bank, in deep water, they were brought up in the trawl. The south part of George's on which we worked, was a smooth, hard, sand bottom inside of the 100-fathom line; in deeper water we encountered a particularly tenacious mud. At the southwest extremity of Brown's Bank, on the slope outside the 30-fathom line, the bottom is covered with a variety of coral growth. We succeeded in getting several small specimens, but had no apparatus to grapple it successfully.

While heaving up the trawl last spoken of, a wreck was sighted, dismasted and water-logged, the seas making a clean breach over it. As soon as the trawl was up, we bore down upon it, lowered a boat, and sent an officer to examine it. From his report and our own observation on board it appeared to be a three-masted, square-rigged vessel of 800 to 1,000 tons, lying on its starboard side, the stern frames gone and the stern floating a few feet above water, the forward body entirely submerged. The bottom was sheathed with yellow metal, hull painted black, laden with petroleum, and to all appearances a wreck of recent occur-

rence, as there were neither grass nor barnacles on it. Its position at 2 p. m., September 5, was latitude $40^{\circ} 14'$ N., longitude $67^{\circ} 00'$ W., within the influence of the Gulf Stream, and may be expected to have an easterly drift of from 20 to 25 miles per day.

While engaged in examining the wreck, the wind was increasing rapidly from the southwest, barometer falling and heavy clouds rising from the westward, a small chopping sea following. At 2.25 p. m. we laid a course for South Shoal light-ship en route for Wood's Holl, and started ahead at full speed. The wind veered to northwest in a heavy squall before dark, and moderated during the evening, the weather clearing. At 7 a. m. on the 6th we passed the South Shoal light-ship, arriving at Wood's Holl at 1.30 p. m.

Capt. Jacob Almy, fisherman expert, reports as follows viz:

"We left Portsmouth, N. H., on August 28, and, passing the Isle of Shoals, ran to the northward of George's Bank. On the 29th the weather was stormy and rainy, the wind increasing in force to a moderate gale. At 2.30 a. m. on the 30th, saw a number of small schools and one very large school of mackerel. They did not show after daylight, though plainly visible at night. They were about 10 miles E. by S. from the shoal part of Cashes' Ledge, in about 100 fathoms of water, latitude $42^{\circ} 52'$ N., longitude $68^{\circ} 32'$ W. At 2 p. m. on the 30th saw a school of porpoises. On the morning of the 31st saw a swordfish. During the day saw several whales and 3 schools of porpoises. On September 1 saw two fin back whales. At 6.30 p. m. on the 2d, in latitude $41^{\circ} 45'$ N., longitude $65^{\circ} 34'$ W., saw quite a large school of mackerel working rapidly to windward.

"On the 5th instant, sighted a wreck and ran towards it. I went in the dinghy to examine it and found it to be a large square-rigged three-masted vessel almost submerged. The bow floated very deep, while the stern was perhaps 5 feet out of water. Could not make out her name. As we pulled to leeward of the wreck, we noticed the smell of petroleum, which led us to suppose that such was her cargo. I do not think that she had taken fire, as there were no signs of burnt wood. Her spars were gone, the foreyard hanging by the topsail sheets. She showed no signs of having been in collision. She was floating starboard side down, and had been in the water but a short time. Her length was probably 200 feet, and she was about 800 tons register. The sea was constantly breaking over her. Her position was latitude $40^{\circ} 14'$ N., longitude $67^{\circ} 00'$ W. We arrived at Wood's Holl on September 6."

We were detained several days making necessary repairs on the boilers, and on the 10th went to New Bedford for coal, returning on the 12th. We were detained by unsettled and foggy weather until 4.55 p. m. on the 19th instant, when we left with a large party of naturalists and fishermen on board to make another examination of the tilefish grounds to the southward of Martha's Vineyard. Light easterly airs,

clear weather, and smooth sea promised a favorable opportunity for our investigations the following day.

We passed through a school of small fish outside of No Man's Land, with numerous squid among them. We failed to identify the fish, but the experts on board declared that they were not mackerel. The weather was clear and pleasant the following morning, with light breeze and long swell from the eastward. At 6.55 a. m. lowered the dinghy and sent off a fishing party with trawl lines baited for tilefish. The gear was set in 70 fathoms, latitude $40^{\circ} 5' N.$, longitude $70^{\circ} 34' 45'' W.$ As soon as the boat was clear we put the trawl over, continuing to work in the vicinity, keeping the fishermen in sight until they returned at 11.35 a. m., reporting a remarkable absence of fish of all kinds, but two hake and one whiting having been taken on the 950 baited hooks. At 2.45 p. m. the trawl line was set again in 111 fathoms, latitude $40^{\circ} 01' 50'' N.$, longitude $70^{\circ} 39' 20'' W.$, with the same number of hooks baited, and was taken up at 6.45; a few hake, skate, and whiting were taken, but no tilefish. Six hauls of the trawl were made during the day in from 65 to 168 fathoms, the forms taken corresponding very closely with those taken in this locality in previous years. The morning of the 21st was clear and pleasant, with light breeze from northeast, increasing during the day to a fresh breeze and moderate sea. At 6 a. m. sent a fishing party away with trawl lines and 950 baited hooks, which were set in 117 fathoms, latitude $40^{\circ} 01' 50'' N.$, longitude $70^{\circ} 59' W.$ The beam trawl was put over and work continued within sight of the boat till 10.30, when the party returned, having taken a swordfish, several skate, hake, and whiting, but no tilefish. Our supply of bait being exhausted, we stood to the southward into deeper water for dredging, and at 1.40 p. m. put the trawl over in 1,000 fathoms, latitude $39^{\circ} 42' 50'' N.$, longitude $71^{\circ} 4' W.$ After dragging it the usual time, we commenced heaving up, but soon discerned that it had gone into the soft mud so deeply as to anchor the ship; the greatest care was observed in heaving, and finally the trawl cleared the bottom and was hove up, but there was nothing in the net, the lashing having given way and let the contents out. One of the trawl-wing bags was full of mud and some small specimens, and the trawl beam was bent so that the runners nearly met. The dredge rope was stranded also about 40 fathoms from the end. A new trawl was rigged, the rope repaired, and at 6.23 p. m. it was put over in 1,022 fathoms, latitude $39^{\circ} 44' 30'' N.$, longitude $71^{\circ} 04' W.$, and at 7.28 it was down with 1,350 fathoms out on the dredge rope. The engines were stopped and the vessel allowed to drift with the wind and sea, which gave us all the speed required. At 8.13 began heaving up, and at 9.22 the trawl was safely landed on board, with a large and interesting collection of specimens. The wind was blowing a fresh breeze by this time, with a dangerous sea for dredging; in fact, the safe landing of the trawl was due to the man in charge of the hoisting engine, who

adapted its speed to the motions of the vessel so skillfully that the danger from the heavy swell was reduced to the minimum.

Serial temperatures and water specimens were taken both yesterday and to-day. A reference to the table will show that we encountered the intervening strata of warm and cold water so marked in this region, and which, in former years, caused us to distrust our instruments on many occasions. The meager results from surface towing and from the trawl wings was remarked by the naturalists. The last haul was taken after dark by aid of the electric light, which enabled us to work with practically the same facility as in broad daylight. At 9.40 p. m. started for Wood's Holl, arriving at meridian on the 22d.

Boiler-makers were at work until the 19th of September, when at 4.10 p. m. we left port for an off-shore dredging trip. At 9.02 a. m. the following day we sounded in 1,342 fathoms, globigerina ooze, latitude $39^{\circ} 29' N.$, longitude $70^{\circ} 58' 40'' W.$, and at 9.38 put over the beam trawl, veering to 1,900 fathoms of rope. It was up again at 1.03 p. m., the net containing a large number of specimens. It was cast again at 2.44 p. m. in 1,451 fathoms, latitude $39^{\circ} 22' 20'' N.$, longitude $70^{\circ} 52' 20'' W.$ The bottom specimen brought up in the Sigsbee cup was the same as that of the former cast, but the trawl contained a granite stone weighing 170 pounds, several small stones, small pieces of cinder, and lumps of hard clay; there were also several small specimens of what appeared to be oxidized iron. The haul was very successful, being particularly rich in foraminifera. As soon as the trawl was up, a set of serial temperatures and specific gravities was taken to 1,000 fathoms. A temperature of 66° Fahr. was found at 25 fathoms, $65\frac{1}{2}^{\circ}$ Fahr. at 60 fathoms, and $57\frac{1}{2}^{\circ}$ Fahr. at 40 fathoms. These strata of cold and warm water are the rule rather than the exception in this locality, but thinking that possibly the observation at 40 fathoms had been read incorrectly, it was verified, using another instrument which registered $55\frac{1}{2}^{\circ}$ Fahr. At 8.22 p. m. we started ahead S. $\frac{7}{8}$ W. (magnetic), running on that course till 5.30 a. m., October 1, when we sounded in 1,917 fathoms, latitude $37^{\circ} 56' 20'' N.$, longitude $70^{\circ} 57' 30'' W.$, bottom globigerina ooze, and at 6.18 put the beam trawl over, veering to 2,600 fathoms. It was on the bottom at 8.04, and at 9.04 we began heaving in, landing it on the deck at 10.42 a. m., having made a successful haul. While the trawl was down we picked up a piece of drift board painted on one side and whitewashed on the other, a 3-inch pine plank, and a piece of pine timber 10 inches square and about 30 feet in length. They had been in the water from four to six weeks.

At 2.08 p. m. the beam trawl was lowered again, in 2,221 fathoms, latitude $37^{\circ} 40' 30'' N.$, longitude $70^{\circ} 37' 30'' W.$ It was down with 3,000 fathoms of rope out at 4.03 p. m., dragging till 5.14 p. m., and was landed after a successful haul at 7.24 p. m. Light to moderate winds prevailed, beginning at SSW., and veering round the compass during the day. At 7.34 p. m. started ahead SSE. (magnetic), ran till 3.26 a.

m., and lay to until daylight, about 5.30 a. m., when we sounded in 2,949 fathoms, globigerina ooze, latitude $37^{\circ} 12' 20''$ N., longitude $69^{\circ} 39'$ W., near the center of the Gulf Stream. The sinker, 64 pounds weight, was thirty-four minutes in reaching the bottom, and the specimen cup came up in thirty-six minutes. The thermometer registered at some intermediate depth not far from the surface, having capsized in some way in its descent. The net of the beam trawl was examined with great care, and every foreign substance removed, so that there should be no doubt as to whether specimens found were taken during the haul, or were in the net when it went down.

At 7.14 a. m. the trawl was put over, reaching the bottom at $10^h 13^m 30^s$, having veered 4,100 fathoms of rope. At 12.54 p. m. began heaving up, and at 3.18 p. m. it was landed on deck. It was a successful haul in every respect. The moderate breeze of the morning increased to a strong wind with heavy swell before the trawl was up, making it doubtful whether we would succeed in landing it. A set of serial temperatures and specific gravities were attempted after finishing the haul, but the strong current, high wind, rugged sea, and threatening weather forced us to give it up after having veered 300 fathoms of rope.

The method adopted to regulate the drift was at least original. The current of the stream was so strong that the trawl would not take the bottom, and to effect this object an officer was stationed on the fore-castle with a dredging quadrant constantly observing the angle of the dredge rope, the engines being moved with sufficient speed to maintain it within certain prescribed limits.

At 4.30 p. m. there was a moderate gale from SW. Hove to under fore storm stay-sail, head to the southward, drifting rapidly with the stream about NE. by E. At midnight it was still blowing a moderate gale, with heavy sea, barometer 29.76, the air exceedingly sultry, and incessant flashes of lightning in every direction. At 1.40 a. m., 3d instant, we started ahead N. and ran under moderate speed till 11.05 a. m., when, wind and sea having moderated, we sounded in 1,628 fathoms, globigerina ooze, latitude $39^{\circ} 22'$ N., longitude $68^{\circ} 34' 30''$ W., and at 12.13 p. m. put the beam trawl over, veering to 2,300 fathoms. There was still a fresh breeze from NW., with heavy swell and very strong stream. The trawl was down at 1.59, dragged till 3.08, and was landed at 4.25 p. m. There were some interesting specimens, but most of the things were washed out of the net on the way up. At 4.31 p. m. we sounded in 1,686 fathoms, globigerina ooze, latitude $39^{\circ} 18' 30''$ N., longitude $68^{\circ} 24'$ W., and at 5.15 p. m. put the trawl over, veering to 2,650 fathoms. It was on the bottom at 7.10, began heaving up at 8.15, and landed it on deck at 9.39 p. m. The heavy swell and strong stream combined washed a large proportion of the specimens from the net, but several new or rare species were secured. A course was laid to the northward as soon as the haul was finished and the speed regulated so as to strike the 100-fathom line in longitude $67^{\circ} 50'$ W. at daylight, where

we proposed setting a trawl line for tilefish. We were on the ground at the proper time, but the weather was so boistrous that it was not considered prudent to lower a boat; it was too rough even for dredging, and as our coal supply was nearly exhausted, we started for Wood's Holl. We encountered strong head winds during the day, finally anchoring in Tarpaulin Cove at 10.40 p. m., where we remained till 6 a. m. on the 5th, when we got under way and arrived at Wood's Holl at 6.40 a. m., making fast to our moorings.

We remained in port till the morning of October 11, when we left for Newport, R. I., for coal, arriving at the latter place during the afternoon. Capt. Jacob Almy, expert fishermen, left the ship on the 12th, his term of service having expired. It may not be out of place for me to mention here that he has been of great service to us in his specialty. At 2.45 p. m. we commenced coaling from a schooner alongside and finished during the afternoon of the following day, having taken on board 98½ tons.

The weather, which had been unsettled with fog and rain since the 9th, cleared on the 15th, and at 5.30 p. m. the following day we got under way and proceeded to sea. We had on board, in addition to the ship's company, Capt. J. W. Collins, expert fisherman, and Mr. Sanderson Smith and Ensign W. S. Safford, naturalists.

After passing out of the harbor we stood toward Block Island, and, leaving it on the starboard hand, ran 10 miles to seaward, then changed the course to pass 10 miles south of No Man's Land, thence to South Shoal light-ship, the primary object of the cruise being a search for mackerel, menhaden, &c. With a view of gaining some knowledge of their migrations, we took the direction in which they would be most likely to appear if there were any schools on the Block Island ground. We saw none, however, and after passing the light-ship, stood for the Fishing Rip, where the schools east of Cape Cod usually disappear when leaving the coast. We saw no signs of fish on the surface, and, the water being too rough for boat work, we laid a course for Cape Cod, anchoring in Provincetown Harbor at 10.55 p. m., where we found the mackerel fleet nearly 300 in number. They got under way at daylight the following morning, the majority standing for Barnstable Bay, some going outside of Cape Cod, and others in the direction of Stellwagen Bank. Captain Collins visited several vessels during the morning to ascertain as far as practicable the movements of the schools of mackerel on the New England coast. The captains all stated that but few fish had been taken for five days, owing to unfavorable weather, and it was difficult to say where the fish were now. At 11.55 a. m. we left Provincetown, observing the fleet in Barnstable Bay as we passed out, and later those off Cape Cod, but there were no boats out. Having run about 10 miles to the eastward of Race Point, we steamed across Boston Bay and at 6.10 p. m. anchored outside of Ten Pound Island, Gloucester Harbor. The day ended with fresh southerly winds and unsettled weather. We ob-

tained but little information here, unfavorable weather having practically put a stop to mackerel fishing for nearly a week. Fresh southerly winds held during the 19th, followed by fog and drizzling rain on the 20th, ending with strong northeast winds, which continued through the 21st. The morning of the 22d opened with a moderate northeast wind and clear weather. At 6.50 a. m. we left Gloucester Harbor and steamed to the southward, passing to the eastward of Stellwagen Bank about 15 miles to seaward of Cape Cod, thence to South Channel, taking the course usually followed by mackerel when leaving the coast. No fish were seen, however, till about 10.30 p. m., when, in the vicinity of Fishing Rip, small bunches of tinker mackerel were observed from time to time under the bow. There were no large fish among them. It was our intention to use lines, gill-nets, &c., in this locality, but unfavorable weather made it impracticable to lower a boat or carry on operations of any kind with a probability of success. Having cleared the channel we stood for the South Shoal light-ship, passing it at 3 a. m., No Man's Land at 8.50 a. m., and, at 12.30 p. m., latitude $41^{\circ} 07' 30''$ N., longitude $71^{\circ} 07'$ W., in 18 fathoms of water, on Cox Ledge, we lowered the dinghy and set a trawl-line with 500 hooks. While the boat was absent several hand lines were used by the crew; 13 codfish, 11 dogfish, and 1 hake were taken. At 3.12 p. m. the dinghy returned to the ship, having taken on the trawl-line 21 codfish, 50 dogfish, 30 skate, 2 sea bass, 1 goosefish, 1 hake, 2 lobsters, &c. The majority of the codfish were females with partially developed roes; there were many dogfish also with half-grown young. All the fish taken were carefully examined for parasites. During the afternoon there were unmistakable signs of a northeaster approaching, and as our coal was getting low I considered it advisable to make a port as soon as practicable. With this object in view we started for Sandy Hook, under steam and sail, as soon as the dinghy was hoisted, thinking we might possibly get in before the storm reached us; but at 8 p. m. it was blowing a moderate gale with thick, misty weather. The wind and sea were increasing rapidly, and as it was not desirable under the circumstances to reach Sandy Hook before daylight, all sail was taken in and the engines slowed down. We ran before wind and sea till 4.45 a. m. on the 24th, when we hove to head to wind about 15 miles east of the light-ship, the weather being very thick. At 6.35 a. m. we started ahead under low speed, and at 11.10 a. m. anchored inside of Sandy Hook.

The gale of last night was the heaviest this vessel ever encountered at sea, and consequently her behavior was observed with great care. The rolling motion was, as usual, remarkably, easy but the pitching rather greater than it should be; the engines worked well. Sprays were flying over the rail fore and aft, but we shipped no heavy seas, and the vessel sustained no damage whatever.

At 7.30 a. m. on the 25th we got under way and steamed to the navy-yard, arriving at 11.30 a. m. Preparations were made for coaling, and

at 2.30 p. m. the next day, Friday, we commenced taking it on board from a barge alongside and finished on Monday, having received 98 tons. We received paymaster's stores on Wednesday, October 31, and at 1.10 p. m., November 4, left the navy-yard and proceeded on our cruise. The weather was hazy with light westerly winds and smooth sea.

Having passed Sandy Hook, we steamed SSE., keeping a lookout for schooling fish, and at 6.53 a. m., the following day, sounded in 1,209 fathoms, globigerina ooze, latitude $38^{\circ} 44' N.$, longitude $72^{\circ} 38' W.$ At 7.24 put over the beam trawl, landing it on the bottom at 8.43, with 1,800 fathoms of rope out. It dragged till 9.45 and was up at 10.54 a. m. At 11.14 a. m. we sounded again in 1,091 fathoms, globigerina ooze, latitude $38^{\circ} 47' 20'' N.$, longitude $72^{\circ} 37' W.$, and at 11.46 put the trawl over, veering to 1,600 fathoms on the dredge rope. It was one hour twenty-five minutes going down, dragged one hour, and came up in fifty-six minutes. Both hauls were very successful, bringing up large numbers and a great variety of specimens. At 3.41 p. m. we sounded in 991 fathoms, blue mud, latitude $38^{\circ} 48' N.$, longitude $72^{\circ} 40' 30'' W.$, and at 4.10 put the trawl over, veering to 1,500 fathoms; time going down fifty-five minutes; on the bottom one hour and sixteen minutes, and fifty-sixty minutes coming up. There were but few specimens in the net, indicating that it had been on the bottom but a short time. A modified form of wing nets, having pockets to prevent specimens from washing out, was used for the first time to-day with the trawl; and a boat dredge with light canvas bag was attached to the end of the trawl net to bring up a specimen of the bottom. After the trawl came up a set of serial temperatures and specific gravities were taken from the surface to 900 fathoms, and at 9.32 p. m. we started ahead SSW. for the night. We had light winds from W. to SSE. during the day, with clear weather and smooth sea; a perfect day for our work.

At 6.06 a. m. on the 6th we sounded in 1,395 fathoms, globigerina ooze, latitude $37^{\circ} 50' N.$, longitude $73^{\circ} 03' 50'' W.$ At 6.44 put the trawl over, and veered to 2,100 fathoms on the dredgerope; time going down, one hour thirty minutes; on the bottom, one hour thirty-one minutes; coming up, one hour seventeen minutes. It was an excellent haul; the trawl net contained a large number of interesting specimens, the wing nets caught a variety of minute forms, and the boat dredge at the tail of the trawl net came up full of foraminiferous ooze. At meridian we sounded again in 1,497 fathoms, globigerina ooze, latitude $37^{\circ} 41' 20'' N.$, longitude $73^{\circ} 03' 20'' W.$, and at 12.37 p. m. put over the trawl veering to 2,300 fathoms, the time of going down being one hour forty-seven minutes; on the bottom, one hour nineteen minutes; coming up, one hour fourteen minutes. At 5.14 p. m., latitude $37^{\circ} 34' 48'' N.$, longitude $73^{\circ} 03' 15'' W.$, we sounded in 1,542 fathoms, globigerina ooze, and took a set of serial temperatures and specific gravities from the surface to 900 fathoms; the thermometer at 1,000 fathoms failed to register. At 8 p. m. started ahead WSW. with the intention of reach-

ing a depth of 100 fathoms at daylight and setting a trawl line for tile-fish. The weather was clear and pleasant through the day with light southerly and westerly winds and smooth sea, but during the evening it clouded up and the wind increased to a strong breeze from WSW. with passing showers.

At 6.05 a. m. on the 7th we sounded in 197 fathoms, sand and shells, near the spot where we intended setting the trawl line, but the wind and sea were so high that it was impracticable to lower a boat or, in fact, to put a dredge or trawl over in safety. The day following our departure from New York, William Hall, landsman, engineers' force, was taken seriously ill with pneumonia complicated by an attack of pleurisy. He was in a critical condition, totally unable to survive a protracted gale which we were liable to encounter at any time in the region of Cape Hatteras during the month of November. Therefore I determined to transfer him to the United States naval hospital at Norfolk, Va., as soon as possible, and at 6.43 a. m. started ahead at full speed for that place. It was blowing a moderate gale from NW. with heavy sea during the forenoon, moderating later in the day as we approached land, and at 4.45 p. m., when we anchored off Fortress Monroe, it had fallen to light westerly airs. At 6.38 on the morning of the 8th we got under way for Norfolk, arriving at 8 a. m.; transferred the patient to the hospital, and at 11.45 a. m., left the navy-yard and proceeded to sea. The winds were variable during the day from light to moderate with pleasant weather and smooth sea. We passed Cape Henry at 3.17 p. m. and steamed to the southward, passing within range of the lights along the coast, keeping the usual lookout both on deck and at the mast-head for schools of fish. At 6.50 a. m. on the 9th we sounded in 19 fathoms, 19 miles NE. by E. (magnetic) of Hatteras light and put over all available hand lines baited with menhaden. The results of half an hour's fishing was one shark, and, after changing ground to 16 fathoms, 15 miles E. by N. of Hatteras light, another one was caught about 4 feet in length. Its stomach was found to contain squid enough to fill an ordinary deck bucket. Having satisfied ourselves that there were no fish to be taken here, we put over the trawl, which demonstrated the absence of life on the bottom, 1 star-fish and 3 small crabs representing the marine life found in the net. Four more hauls of the trawl with boat-dredge attached were made during the day in from 48 to 938 fathoms with excellent results. The last haul was finished at 11 p. m., with a moderate southwest gale and heavy sea, which sprung up rapidly from a fresh breeze and moderate swell during the afternoon. As soon as the trawl was landed, we steamed inshore to make a lee under Cape Hatteras, and at 2.40 a. m. the following day hove to in 15 fathoms, the light bearing SW. by S., where we found comparatively smooth water. Three hauls of the trawl with dredge attached were made in shoal water during the day, wind and sea being too heavy to admit of working in deep water off shore.

The wind moderated during the night, and on the morning of the 11th

we steamed to the eastward about 30 miles, sounding at 7.54 a. m. in 843 fathoms, mud and fine sand, latitude $35^{\circ} 49' 30''$ N., longitude $74^{\circ} 34' 45''$ W., and at 8.25, put the trawl over with wing-nets and dredge attached. It came up at 11.30 a. m. containing a large number and great variety of specimens, many of them exceedingly rare. Several pieces of resin came up in this haul. Various theories were advanced to account for their presence, but the romance was finally destroyed by the discovery of a piece with the fragment of a barrel stave adhering to it.

Another equally successful haul was made in 888 fathoms, blue mud and fine sand, latitude $35^{\circ} 45' 23''$ N., longitude $74^{\circ} 31' 25''$ W. The trawl was landed on deck at 3.41 p. m. At 3.55 we sounded in 1,066 fathoms, green mud, latitude $35^{\circ} 44' 30''$ N., longitude $74^{\circ} 28' 45''$ W., and commenced taking serial temperatures and water specimens; but the wind and sea, which had been gradually increasing during the day, compelled us to stop at 600 fathoms. At 5.30 p. m. we started inshore to make a lee. At 11.40 p. m. made Body's Island light, and at 12.20 a. m. on the 12th hove to and drifted till 4 a. m., when, the weather having moderated, we steamed to the eastward, and at 8 a. m. sounded in 40 fathoms, sand and gravel, latitude $36^{\circ} 16' 15''$ N., longitude $74^{\circ} 51' 20''$ W. As many of our fishing-grounds are on bottom of this character we tried the hand-lines, but without success. It was hardly a fair test, however, as the bait was poor and the weather unfavorable. After our attempt at line-fishing, we ran to the eastward again about 5 miles, with the intention of dredging, but wind and sea increased so rapidly that we were obliged to give it up. The amount of coal remaining would admit of but one more day at sea, even if the weather were good, and, as the NW. gale just setting in might make it impracticable for us to work for some days, I considered it advisable to make a harbor as soon as possible. At 10 a. m. started for the capes of the Chesapeake. Wind and sea being ahead, we made slow progress until up with the land, when the weather moderated, and at 10.35 p. m. we made Cape Henry light. A constant and vigilant watch has been kept for fish during the cruise, but nothing has been seen, except an occasional school of porpoises. At 1.15 a. m. on the 13th we passed Cape Henry, and at 5.30 p. m. anchored off Marshall Point, Potomac River, for the night. At 6.40 a. m. the following day we got under way, and arrived at the navy-yard, Washington, D. C., at 8.07 a. m.

The details of our fishing operations will be found in the comprehensive report of Capt. J. W. Collins, fisherman expert, which he made at the close of the cruise, as follows, viz:

REPORT OF J. W. COLLINS.

WASHINGTON, D. C., *November 17, 1883.*

SIR: Acting in accordance with instructions from Prof. Spencer F. Baird, United States Commissioner of Fish and Fisheries, I left Boston at 3.35 p. m. on Saturday, October 13, and the same evening reported

on board the ship at Newport, R. I., as soon after the arrival of the train as was practicable.

The instructions referred to above stated that—

“The principal object of this cruise will be to learn what may be ascertained in regard to the rate of travel, places of occurrence, extent of distribution, and all other phenomena connected with the southward movement of the menhaden, mackerel, bluefish, &c.; and particularly to ascertain the precise region where they seem to pass away from view, which is supposed to be the deep waters off Cape Hatteras.

“The occurrence of fishing vessels and their proportional abundance in different localities should also be noted.

“If the opportunity permits to test the hand or the trawl line in determining the presence of particular kinds of fish at certain depths, I should be pleased to have this done.”

In order to carry out these instructions, it was necessary that a supply of suitable bait should be obtained for the cruise; not only because it would be indispensable in case hand or trawl lines were to be used, but also because it might be found eminently serviceable for trolling up mackerel or bluefish to the surface of the water should the weather prove favorable and the fish could not be otherwise seen.

Newport being a favorable locality to secure menhaden, which were thought to be more desirable for bait than any other species of fish, it was decided to remain there until Monday, October 15, by which time it was hoped the weather would prove favorable, not only for the local fishermen to pursue their operations, but also for us to proceed to sea and make the observations alluded to above.

It should be stated here that the weather during the previous two or three days had not been good for fishing, and therefore few if any menhaden had been taken in the vicinity of Newport; but even if there had been fair catches (it being Saturday evening when I joined the ship), it would have been impracticable to get bait so late in the week, since the catch would have all been disposed of. There was, therefore, nothing to do but to wait.

The evening of the 13th was dull with a drizzly rain and wind light from the southward.

Sunday, October 14.—The wind was moderate, veering from SW. in the morning to the westward and northward, until in the evening it was WNW. Fog and rain prevailed during the morning, followed in the evening by clearing weather.

Monday, October 15.—The wind blew from NNE. and NE. a brisk breeze most of the day, with decidedly cool weather.

I went ashore in the morning and interviewed the fishermen and fish-dealers to learn what were the prospects of obtaining bait. They all agreed in stating that there was little chance with the prevailing wind and weather of any menhaden being caught either in traps or by seining gangs. Having been referred to Mr. Noah Thompson as the person

most likely to have menhaden bait at this season, I made an engagement with him to furnish us with what we wanted if it could be obtained, and he immediately ordered a boat to beat up river, and if any fish were taken by the seining gangs to bring to Newport enough for our use. Mr. Thompson thought the boat might return about 5 p. m., but she did not come at that hour, nor, indeed, did she arrive during the evening. Her non-arrival was attributed to the cold breezy weather, which, it was supposed, had prevented the fishermen from making any hauls of menhaden. It should also be mentioned that I bought 3 barrels of salt (barrels included) from Mr. Thompson, to be used for salting any fish we might be fortunate enough to take, and which might be useful for food or bait. It was also necessary to have salt to put on the nets in case that, after being set, no opportunity offered for drying them.

Tuesday, October 16.—The weather was clear and cool with a moderate breeze from NE. to NNE. During the day we succeeded in getting 1 barrel of fresh menhaden, which had been taken in fish ponds or traps and hauled to town on carts. No fish, so far as we could learn, were caught in seines.

At 5.30 p. m. we got under way, and stood out of Newport Harbor. After getting out past Brenton's Reef, we steered so as to go to the westward of No Man's Land, after which the course was changed so that the ship should pass a few miles southward of South Shoal light-ship. This took the ship over the ground where mackerel, if anywhere in this vicinity, would be most liable to occur, and also where it was not altogether improbable that menhaden might be met with. No schools of fish were seen, however, though a good lookout was kept. It may not be out of place to remark in this connection that easterly winds are particularly unfavorable for fish to rise to the surface, and especially when such winds are accompanied with cool weather.

Wednesday, October 17.—The wind still continued easterly, varying during the day, from east to northeast, and moderate; weather cool. At 6.35 a. m. South Shoal light-ship was abeam about $2\frac{1}{2}$ miles distant. Having steamed about 10 to 12 miles on a SE. by E. $\frac{1}{2}$ E. course after passing the light-ship, we then ran ENE. $\frac{1}{2}$ E. (mag.) 20.1 miles, thence 44 miles N. by W. $\frac{1}{4}$ W. (mag.). At 4.10 p. m. we changed our course to NW. by N. (mag.); ran $23\frac{1}{2}$ miles.

These courses took us up South Channel and to the eastward of Fishing Rip, and thence to Cape Cod, the ship passing over the ground where there was the greatest probability of meeting with schools of mackerel that might be moving off the coast in a southerly direction. Notwithstanding that a sharp lookout was kept, not the least indication of the presence of mackerel was observable. No sea-geese (*Phalaropes*), gannets, or other birds that might denote the presence of bodies of fish, were seen, neither did we observe any porpoises, whales, blackfish, or other species which prey on mackerel, while I failed to see a single "slick" on the water—a "sign" of the presence of fish which is worthy

of notice. It is true that hagdons (*Puffinus major*) were abundant, and a flock of these birds followed the ship all day, and we also saw several jaegers, and, what was more noticeable, we saw two fine specimens of great skua gull at 10 a. m., when the ship was about 30 miles E. by N. from South Shoal light-ship. As, however, the presence of these birds is no indication that schools of pelagic fishes are in the vicinity, no importance was attached to their appearance on the grounds passed over. At 10.55 p. m. we anchored in Provincetown Harbor, where, lying at anchor, many of them with mainsails set, a fleet of 300 sail or upwards of mackerel schooners was seen.

Thursday, October 18.—Began with light easterly wind and fine, clear weather. At 4 a. m. the first of the fishing schooners began to get under way and, being called, in accordance with orders, I turned out and made preparations for boarding some of the vessels. At 5 a. m. I went on board of the *Ellen M. Adams*, of Gloucester, and later boarded the *Ada E. Terry*, of the same port, and the *Alice* of Portland. The captains of these vessels agreed in stating that no mackerel of any consequence had been taken for the previous five days because of the prevalence of fresh easterly winds and rough sea. Therefore they were unable to give any definite information relative to the movements or present locality of the mackerel. Each one, however, had his own idea as to the whereabouts or movements of the fish, though it is no more than fair to say these were mere speculations, based on supposition, or on rumors which might be more or less incorrect. The fact is that at this season, when mackerel are generally moving with greater or less rapidity along the coast or departing from it, there is not only great difficulty in keeping run of them during bad weather (when the fishing fleet is kept in harbor nearly all the time), but it is practically impossible for the most experienced fishermen to do better than to guess where fish may be met with in greatest abundance. Thus the skipper of the *Ellen M. Adams* thought mackerel would be found broad off Cape Cod, 30 to 40 miles east of Race Point or Highland light; the captain of the *Alice* had heard that mackerel had been seen a few days previous off the coast of Maine, and believed it possible that a body of fish might still be found to the eastward of Cape Ann; while Captain Terry, of the *Ada E. Terry*, held the opinion that the greater part of these fish had passed to the southward, out by Cape Cod, and believed little more would be done by the fleet during the fall. He thought, however, that small quantities of mackerel would probably be taken in Barnstable Bay and vicinity until about the 10th of November, but believed that the fish would, in nearly all cases, have to be tolled up and caught with-hook and line, or else surrounded with a seine after being attracted with bait alongside of the vessel. The skippers of the vessels above mentioned all held the opinion that few schools of mackerel would be seen at the surface in the daytime, and stated that they depended, at this season, chiefly on seeing fish at night when the nights were dark enough to note the presence

of schools by the phosphorescence thrown out by the movement of the mackerel through the water. At this date the moon was so large and the nights so light that there was no probability of seeing fish between sunset and sunrise; therefore few or no vessels staid out except during the day. I bought a barrel of salt herring from Captain Terry, to be used for the purpose of tolling mackerel, &c., as occasion might require.

At 6 a. m. nearly the whole fleet was under way, working out of the harbor with a light easterly air.

At 11.56 a. m. we got under way, and stood out of Provincetown harbor. After passing Wood End we were in plain sight of the fleet of mackerel catchers in Barnstable Bay. The movements of the vessels indicated plainly that no fish were being caught at that time.*

These fish were undoubtedly caught in the day after we had left the fleet. A few of the schooners were lying to, trying to toll mackerel up, but apparently without success, for they were not "manned out," and the other vessels in company were either jogging, with jibs to windward, or running out of the fleet towards Race Point, off and beyond which were several of the mackerel catchers standing out to the eastward. Feeling satisfied that nothing was being done in the bay, the ship steamed out past Race Point and 10 miles beyond it on a northeast course, an opportunity being thus afforded for noting the movements of the vessels which had stood out to the eastward.

It may be briefly stated that not the least indication of the presence of mackerel was apparent. Many of the schooners, which had first gone out to the eastward of Race Point and the highland of Cape Cod, were seen running back, some of them being 10 to 12 miles, at least, off the land; others were still heading off close hauled on a wind while a few were hove to, trying to "raise" fish, but without success.

It being deemed advisable to learn all that could be gathered concerning the whereabouts and doings of mackerel vessels in order to judge more accurately of the movements of the fish, the ship was next headed for Gloucester, where a portion of the fleet was supposed to be. We passed over Stellwagen Bank ("Middle Bank" of the fishermen) and thence to Gloucester, seeing a few mackerel seiners on our way, none of which, however, were catching fish, or, by their actions, gave evidence in any way that mackerel had been seen.

At 6.10 p. m. we anchored outside of Ten Pound Island, and I went ashore to gather what information I could relative to the catch of mackerel, &c.

The wind, which had been light during the forenoon, increased during the latter part of the day, and in the evening there was a fresh southerly breeze.

* The report of the Boston Fish Bureau for Friday, October 19, states that "on Thursday (October 18), the weather was favorable and a fair catch of mostly small fish (mackerel) was made in and near Barnstable Bay; 800 barrels arrived here fresh this morning."

Friday, October 19.—During the morning I interviewed several of the fishing skippers, and also the fitters and owners of the fishing vessels, but failed to gather any important information concerning mackerel. The fishermen here, as at Provincetown, had been prevented by the prevalence of unfavorable weather from making any satisfactory trials to catch mackerel for a week or thereabouts. Only a comparatively small fleet remained at Gloucester, the majority of the vessels having gone over to Cape Cod, the impression being somewhat general among the fishermen that the probabilities of catching mackerel were greater there than off Cape Ann.

Capt. S. J. Martin, of the U. S. Fish Commission (who is stationed at Gloucester for the purpose of obtaining full and reliable information concerning the movements of fishing vessels, catches of fish, &c., and who is probably better informed on these subjects than any one else), told me that during the past week, or thereabouts, the fleet had been kept in harbor, and consequently little or nothing was known or could be known of the movements, presence, or absence of mackerel on the coast. On Tuesday, October 16, a fleet of 315 mackerel vessels lay in Gloucester Harbor, but since that time most of them had gone over to Provincetown. So far as Captain Martin had been able to learn by constant inquiries among the fishermen arriving from the banks and elsewhere, no mackerel had been seen at the surface, either at night or day. As these fish are usually disinclined to come near enough the surface, during the prevalence of easterly winds in autumn, to be seen by day, and, as previously mentioned, the moonlight for several preceding nights made it improbable, at least, that their presence could be detected after sunset, the fact that mackerel were not reported by incoming vessels did not prove that they might not be still on some parts of the coast in considerable abundance. At the same time, the fact that no schools of mackerel had been observed for several days and nights past by the experienced crews of the numerous fishing vessels coming into port from various directions rendered it extremely improbable that we could be successful in a search for them until more favorable weather set in.

The weather to-day was especially unfavorable, the wind blowing fresh from S. to SSW. In the afternoon, a dispatch was sent to General Hazen, Chief Signal Officer, U. S. A., at Washington, to learn the probabilities for the next 60 hours. No reply was received this evening.

Saturday, October 20.—A reply was received this morning, at 9 o'clock, from General Hazen, stating that the probabilities indicated SW. to NW. winds and clearing weather.

A drizzling rain and fog during the first part of the day was followed in the evening by a smart NE. squall, which settled down to a strong steady breeze. This kept the mackerel vessels in harbor and also prevented us from going to sea, since there was no opportunity of making anything like satisfactory observations.

Sunday, October 21.—The wind blew fresh all day from NE., and there

was considerable sea running outside the harbor. Fishing and coasting vessels arriving in port came in under close-reefed sails.

Monday, October 22.—At daylight there was a moderate northeast breeze and clear weather. Got under way at 6.50 a. m. and stood out of Gloucester Harbor. After passing Eastern Point, the ship was steered on a course which took her a little northeast of Stellwagen Bank, thence down by Cape Cod, passing the Highland at a distance of about 12 to 15 miles. From this point the course took us out the south channel, over the ground where mackerel would be most likely to occur when making their fall migrations southwardly. A sharp lookout from aloft was kept throughout the entire day. I spent some time aloft myself, but not the least indication of schooling fish of any kind was observed until about 10.30 p. m., from which hour until 11.30 p. m. scattering small mackerel (tinkers) were seen darting away from the ship's bow. We did not, however, see any large body of these fish, and the presence of those observed would not necessarily indicate that schools of larger mackerel might be met with in the vicinity. Had there been less swell, it might have been advisable to have tried during the day to raise mackerel by throwing out toll bait, but the probabilities are that, even had it been practicable to make this experiment, no good result could have been obtained with the wind from the eastward. Though it is by no means impossible to "raise" mackerel during easterly winds, experience has nevertheless proved that oftentimes they will not follow bait to the surface under such conditions of weather, even where they are known to be abundant.

Tuesday, October 23.—Began with a moderate breeze about ENE. in the early morning, gradually increasing in force as the day advanced. A little before noon we tried with hand-line for cod on Cox Ledge, having got "good bottom," coarse gravel and sand, in a depth of 18 fathoms. Nothing but a dogfish was caught on the first trial. A second trial, a mile or two from where the first was made, in the same depth and on the same kind of bottom, proved more successful, a fine cod, fish having been caught on the single hand-line put out; the dinghy was dropped from the davits, and 500 hooks of a haddock trawl, baited with fresh menhaden, were set. In the mean time all the available hand-lines were baited up with fresh menhaden and put over, the ship lying broadside to the wind and making a very good drift for fishing. As was to be expected at this season, dogfish were numerous and troublesome in so far as they often succeeded in getting hold of the hooks before the cod, notwithstanding that the latter species appeared to be in tolerably fair abundance on the ground; 13 codfish, 11 dogfish, and 1 hake were taken on the hand-lines while the ship was drifting, perhaps, three-fourths of a mile.

The dinghy, having set her trawl at about 1 p. m., began hauling about an hour later; came alongside, and was hoisted up at a little after 3 p. m. Her catch was as follows, namely: 21 codfish (averaging

about 8 pounds each, the extremes being from 3 to 13 pounds); 1 hake, 2 sea bass, 1 cunner, 2 female lobsters (2 averaging 3 pounds each, 1 carrying spawn), 30 small skate, spotted and brier, 1 large spotted skate, 50 dogfish, and 1 goosfish.

It is perhaps worthy of notice that none of the codfish, most of which were females, had roes in an advanced stage of development; they were all of the kind usually known among fishermen as "shore cod"; were plump and well fed, having fat livers. Nearly all of them had a great or less number of small crabs in their stomachs; in a few were found partially digested flounders; while it was interesting to note that two of the codfish had eaten young lobsters 5 to 6 inches long, two of these being taken from one fish and one from another. This, taken in connection with the fact of having caught two full-grown lobsters on the trawl-line, a very unlikely thing to happen, would seem to indicate that this species of crustacean were present in considerable abundance, to say the least, and suggests the possibility of this being a breeding ground of more than ordinary importance for lobsters.

The majority of the dogfish taken were females, and nearly all of these were pregnant, containing from three to seven young ones.

A close examination failed to discover any parasites on the fish taken, either on the gills or outside surface of the bodies.

Speaking in general terms, I should say that the codfish taken were what are termed "ground grubbers" or "ground feeders"; that is, fish which hang about the shore grounds, and do not usually form part of a large school which moves from place to place either in pursuit of food or impelled by the instinct of reproduction.

Sunday, November 4.—Leaving New York in the afternoon, we passed out by Sandy Hook, from which we steered SSE. (mag.). The afternoon and evening were fine, with a gentle breeze varying from SW. to NW., and smooth sea. As we were steering on a course which would take the ship across the track that the mackerel might be expected to take when making their regular autumnal migration southwardly (which is usually performed at or about this date), a bright lookout was kept, and the man on watch at the bow was ordered to report if any fish were seen darting about in the water. Ordinarily the presence of fish in the water through which a vessel is passing can be very readily detected at night by the bright phosphorescent track they leave behind when darting suddenly away to escape from the approaching ship. On moonlight nights, however, it rarely happens that the movements of fish in the water can be detected, unless, indeed, they rise to the surface and their presence is discovered by the noise they make in flapping their tails, rushing, &c.

This evening the moon was rather too bright—at least for some hours—to see any fish. A school of porpoises passed by between 8 and 9 p. m., but nothing else was seen before midnight.

Monday, November 5.—At 12.05 a. m. the lookout reported seeing fish in the water, which he thought might be mackerel. I immediately went

on the forecastle. For about an hour the ship continued to run through scattering small fish, which could be plainly seen as they darted away from the bow. At this time we were between 65 and 70 miles from the "Scotland" light-ship off Sandy Hook, and consequently in the locality where we might reasonably expect to see mackerel therefore; I was much interested in watching for them. None of those fish which we saw were mackerel in my opinion. They were too small even for "spikes."*

No fish were seen after 1 a. m., the ship in the mean time continuing on her course until at a little before 7 a. m., she stopped to obtain soundings, being then about 120 miles from Sandy Hook.

The day was spent in making hauls with the beam-trawl, and the work continued into the evening. In consequence, the large electric (arc) light was hoisted on the starboard side near the fore-rigging. This light threw a bright glare on the water alongside of the ship, and in a few minutes, scattering squid were seen darting about, having been attracted to the surface by the light. They seemed little inclined to bite at a jib, but after much trying, one specimen was taken which was pronounced by the naturalists on board to be the species commonly known as the "flying squid." The locality of this capture was latitude 38° 48' N., longitude 72° 40' 30" W.

At 9.32 p. m., the day's work having been finished, the ship started ahead on a SSW. course, steaming about 7 to 8 knots. At 11.05 p. m., when about 12 miles from the position given above, the lookout reported seeing small fish under the bow. I went on the forecastle at once, but failed to see anything except a large animal which came under the bow, and which was doubtless a turtle. When questioned, the lookout stated that the objects he saw were some distance off, and appeared to be small fish at the surface. Under the circumstances, conjecture as to the species would be useless.

Tuesday, November 6.—The day was spent in making hauls with beam-trawl from deep water, the weather still remaining fine, with moderate southerly to southwest winds.

After finishing the day's work, the ship was started ahead on a WSW. course, in the direction of the Chesapeake, this course crossing a piece of gravelly bottom in about 45 to 50 fathoms, where it was intended to set line trawls the next morning should the weather prove favorable.

Wednesday, November 7.—At daylight there was a fresh and increasing breeze from WNW. veering to NW.—too much wind and sea to set trawl-lines with safety. Ship continued on her course, reaching the anchorage off Fortress Monroe in the evening, having made port to land a sick man.

Thursday, November 8.—The sick man previously alluded to having been landed at Norfolk, Va., the ship got under way and proceeded to sea, passing Cape Henry a little after 3 p. m. After getting out by the

* Mackerel hatched out the previous summer, and which at this season usually attain a growth of 5 inches or thereabouts are called "spikes."

cape, the ship steered southwardly, running down the coast in the direction of Cape Hatteras.

Friday, November 9.—At 7 a. m., tried for fish with hand-lines, these being baited with menhaden, and having various sizes of sinkers and hooks, most of them, however, being ordinary bank and boat codfish gear. We had previously sounded in 19 fathoms, the bottom being fine yellow sand with black specks, and fine broken shells.

This kind of ground is rarely found good for bottom-feeding fish. We caught only a single sharp-nosed shark (or smooth-backed dogfish) about $2\frac{1}{2}$ feet long. Our position at this time was, approximately, 20 miles NNE. $\frac{1}{2}$ E. from Cape Hatteras.

At 8.23 a. m. we sounded again in $16\frac{1}{2}$ fathoms, latitude $35^{\circ} 20' 30''$ N., longitude $75^{\circ} 15' W.$; bottom fine sand and broken shells. Put out hand lines with same result as before, the catch being 1 female sharp-nosed shark about as large as the first.

The beam trawl was put out, but the catch—1 small crevallé, 1 starfish, a few dead shells, and 3 small crabs taken in it—showed a scarcity of such life on the bottom as might serve for food for any of the larger species of fish.

Leaving this position we ran off shore, and at 11 a. m., latitude $35^{\circ} 16' N.$, longitude $75^{\circ} 2' 30'' W.$, sounded in 48 fathoms; bottom blue mud and coarse sand. Tried for fish with 4 hand-lines, those having the heaviest leads, the others being too lightly sinkered to use in this depth of water with any breeze blowing. Nothing whatever was taken on the lines, though they were out almost three-quarters of an hour. In the mean time, a sharp-nosed shark, which had been seen near the surface, was caught on a shark line. The fish was about $4\frac{1}{2}$ feet long, and its stomach contained many partially digested squid.

The beam trawl was put out at 11.40 a. m., but, with the exception of a few specimens of small crabs, brought up nothing which might serve as food for fish.

During the day, when about 3 or 4 miles to the eastward of the position last given, and when we were steaming at full speed, a school of about 25 to 30 porpoises came by the ship, stopped a few moments under the bow, and were off again.

Mr. Miller, the paymaster's yeoman, threw the grains into a small dolphin which was playing around the ship in the evening, and was successful in catching it. The locality of this capture was latitude $35^{\circ} 9' 50'' N.$, longitude $74^{\circ} 57' 40'' W.$

Saturday, November 10.—Several sets of the beam trawl were made in shoal water, 15 to 18 fathoms, northeastwardly from Cape Hatteras, the wind blowing so fresh from the southwest during the day that it was impracticable to dredge off shore. As in previous hauls in this locality, very few forms of life were brought up in the trawl that could serve as food for fish. The result of these numerous trials in this region would seem to indicate almost an entire absence of bottom-feeding fish, for this sandy slope north of Cape Hatteras would appear to be

barren ground. This would, however, have nothing to do with the presence of surface fish, such as find their food in free swimming animals, and it is altogether probable that at certain seasons, these waters may swarm with multitudes of pelagic species making their migrations north or south. So far as known, most of the migratory fishes that pass to and fro by this coast keep close inshore, as a rule, though it is known to fishermen that the bluefish occasionally go off to a distance of 15 to 25 miles from the land, and it is reasonable to suppose that other species may also have similar habits.

In this connection it may be well to remark that one of the principal "signs" of the presence of bodies of fish passing up or down the coast is the appearance of large flocks of sea birds, generally gulls, and fishermen have learned by experience to watch for this indication, especially when engaged in bluefishing. Comparatively few birds were seen on our cruise, these being all gulls, and those which were observed failed to give any indication, by their movements, of the presence of schooling fish, though their actions were carefully watched.

At midday, and for two hours later, the ship at the time lying to, drifting, wind blowing fresh southwest, many turtles were seen, perhaps as many as 30. These showed themselves at the surface for a few minutes, or perhaps only for one or two seconds at a time. None of them seemed to be asleep, and when they rose near us they immediately went under as soon as they caught sight of the ship. Although as many as 3 or 4 were seen up at once, no opportunity offered for their capture.

Sunday, November 11.—Spent the day in dredging with beam trawl in deep water.

Monday, November 12.—A little before 8 a. m. we sounded in 40 fathoms, latitude $36^{\circ} 16' 15''$ N., longitude $74^{\circ} 51' 20''$ W.; bottom dark-gray sand and gravel. We put out 4 hand lines baited with menhaden and tried for fish nearly an hour, but failed to catch anything.

The results of this trial were, perhaps, not quite so conclusive as those previously made, owing to the fact that our bait by this time was in poor condition. It is barely possible that fish might have been caught with better bait. It may, however, be safe to assume that had there been present any large number of fish, the long and careful trial that was made would have resulted in the capture of a few specimens at least.

The wind, which had been blowing fresh from southwest, causing a choppy sea to get up while we were trying for fish, shortly afterward veered to NW., and increased to a moderate gale. The ship headed in for the Chesapeake, and the fishery investigations closed, for the cruise, with the trial above described.

Very respectfully,

J. W. COLLINS.

Lieut. Commander Z. L. TANNER, U. S. N.,

Commanding U. S. Fish Commission Steamer Albatross.

REPORT OF THE NATURALIST, MR. JAMES E. BENEDICT.

I have the honor to report that upon December 14, 1882, I was appointed resident naturalist of the United States Fish Commission, Steamer Albatross, and ordered to prepare a complete outfit of collecting apparatus for that vessel. I found that Capt. J. W. Collins had procured an admirable assortment of nets, comprising trammel and gill nets, and seines fully rigged for use; also a large number of fishing lines, fish-hooks, squid-jigs, &c.; in short, all the implements of use on a fishing vessel.

But much minor apparatus remained to be procured for the ship, such as sieves, fish pans, dishes, and other things necessary in the laboratory, besides alcohol jars and vials.

The full complement of alcohol-tank boxes is forty, of which ten contain four 4-gallon tanks each; sixteen two 8-gallon tanks each, and the remainder one 16-gallon tank each. All these tanks are of copper. Their aggregate capacity is about fifteen barrels. The complement of jars is about two gross of 4-pound butter jars; two gross of 2-pound butter jars; two gross of 2-quart fruit jars; two gross of 1-pint fruit; and two gross of 1-pint fruit, and from two to five gross of each of the cork-jars, from No. 1 to No. 8, inclusive.

Two or three features of the Albatross's equipment should be specially mentioned, viz :

THE MUD-BAG.

It often happens that the bottom is of such a nature that it washes through the netting of the common dredge and trawl, leaving in our hands only the larger specimens, subject to more or less injury by stones and broken shells. To prevent this we have made a tight canvas bag about 3 feet long, and have attached it to the iron frame of a boat-dredge. Thus rigged it is attached to the end of the trawl-net. Besides the larger forms of fish and invertebrates taken with the trawl alone, this contrivance secures from deep water large amounts of foraminifera otherwise lost, and many specimens of worms, crustacea, and mollusca. This alone makes the mud-bag valuable, but it has the further merit of delivering mud and ooze free from slime and fish scales, even under circumstances where they are plentifully found in the trawl-net, as, for instance, when large hauls of fish, star-fish, and holothurians are made.

I estimate that, outside of the foraminifera, the number of species captured by the use of this bag is, oftentimes, from one-third to two-thirds greater than by the trawl alone.

It was found that the lower tray of the sieve, with its one-twelfth inch mesh, permitted most of the foraminifera, annelids, small crustacea, and many minute shells to escape, and, as a remedy, the canvas discharge-pipe was turned from the scuppers into a tub placed under the sieve.

Discharge from the tub is effected by means of three pipes 6 inches in length, inserted in the following order (Plate XLVIII): One $\frac{1}{2}$ -inch pipe, 6 inches from the bottom; one $\frac{1}{2}$ -inch pipe, 6 inches higher than the first named, and in the next stave; one 2-inch pipe, in the stave next to the last named, and 4 inches from the top. The 3 pipes thus afford a sufficient discharge.

Each pipe is muzzled by a linen scum-strainer about 1 foot in diameter and 3 feet long, with the free end closed, giving so large a straining surface that the flow into the tub rarely exceeds the flow out through the strainers. This device preserves an abundance of the most minute foraminifera, and assists in the separation of mud and gravel from organisms, the first largely sinking to the bottom of the tub, the second largely passing into the scum-strainers.

THE ELECTRIC LIGHT IN COLLECTING.

The Albatross was one of the first ships fitted with Edison's electric-light. Properly shaded to protect the eyes of the collector, it is attached to the end of an insulated cable. Although it is capable of being lowered to a great distance, its successful use has thus far been confined within 3 feet of the surface, there being no efficient apparatus for collecting by its aid from greater depths. It has, nevertheless, been of good service. By its use the following crustacea were taken off Montauk Point, Long Island:

Crangon vulgaris;

Cancer;

Homarus americanus;

Palæmenetes vulgaris;

Mysis americanus;

Heteromysis formosa;

Diastylis sculptus;

Idotea irrorata;

Chiridotea Tuftsi;

Ptilochirus pinguis;

Urothea sp.;

Calliopius læviusculus;

Several other Amphipods;

Early stages of various Decapods;

Early stages of various Copepods.

Many small fish were taken by the same means at the above locality. The list of crustacea was prepared by Prof. S. I. Smith.

At Wood's Holl, Massachusetts, the sexual form of *Nereis megalops* swarmed about the light.

In the Gulf stream two species of squids, viz, *Ommastrephes illecebrosus* and *Sthenotuthis Bartramii*, the latter in large numbers, were taken by the squid-gig near the light.

Harpooning or hooking sharks or dolphins in the area of illumination is not uncommon.

Mother Carey's chickens (*Thalassidroma Leachii*, and *T. Wilsoni*), when for some reason the arc light was in use, often came on board and were captured.

Surface collecting was carried on whenever the ship's speed would permit. Long bamboo poles, with fine silk bolting-cloth nets attached, were placed in each gangway in readiness for small surface objects. Surface-nets were used from one of the swinging booms, being thus rigged instead of over the stern, to avoid their loading with cinders, coffee-grounds, &c.

A shark-line was kept in readiness, and a shark occasionally captured and examined for parasites, external and internal.

Porpoises were sometimes harpooned, but the height of the bow of the Albatross renders this a difficult feat.

In all of these operations the seamen showed great willingness to assist, and they even employed a portion of their time off duty in the capture of specimens for the laboratory, many of which proved very fine. They also brought in for preservation many specimens which had fallen from the trawl to the deck unperceived by the naturalists.

During the current year nine cruises were made by the Albatross, and one hundred and sixteen hauls with the trawls and dredges. This number of hauls would seem a small year's work for a ship so well equipped for this special purpose, if the great depth (from 1,500 to 2,900 fathoms) of many of the hauls were not taken into account; also the fact that several cruises were made almost solely to find mackerel and menhaden. The dredging was nevertheless very successful. Many new forms of fish, crustacea, mollusca, echinoderms, and anthozoa have already been described by the several specialists, and many more are still in their hands for description. In addition to the new forms numerous species, formerly rare or little known, were found in such abundance that the National Museum has on hand material enough for many sets, both for educational purposes and for exchange.

REPORT OF ENSIGN R. H. MINER, U. S. N., DEPARTMENT OF FISHES.

The operations of dredging and trawling were commenced on our voyage from Wilmington, Del., to Washington, D. C., in March and continued until our return to Washington in November. They are included within the limits of latitude $35^{\circ} 9' 40''$ N. and latitude $42^{\circ} 32' 00''$ N., longitude $65^{\circ} 21' 50''$ W. and longitude $75^{\circ} 20'$ W. The work for the most part was done in deeper water than had been attempted heretofore by the United States Fish Commission. The ground between these limits was investigated as thoroughly as practicable during the season, and the distribution of species thereon reasonably well determined.

We have succeeded in finding, according to Prof. Theodore Gill, no less than eighteen new species of fish-like vertebrates—one Myzont, one Selachian, and sixteen true Fishes. Trawl lines were set several times, on different dates, for the *Lopholatilus*, but we did not succeed in finding traces of any.

One hundred and sixteen hauls of the trawl and dredge were taken during the season, and the list of species found is as follows, viz.:

LOPHIIDÆ.

1. *Lophius piscatorius*, Linnæus.

MALTHIDÆ.

2. *Halieutæa senticosa*, Goode.

PLEURONECTIDÆ.

3. *Monolene sessilicauda*, Goode.
4. *Citharichthys arctifrons*, Goode.
5. *Pleuronectes americanus*, Walbaum.
6. *Glyptocephalus cynoglossus*, (Linn.) Gill.
7. *Paralichthys dentatus*, (Linn.) Jordan and Gilbert.
8. *Paralichthys oblongus*, (Mitch.) Jordan and Gilbert.

MACRURIDÆ.

9. *Macrurus bairdii*, Goode and Bean.
10. *Macrurus carminatus*, Goode.
11. *Macrurus asper*, Goode and Bean.
12. *Coryphænoides rupestris*, Gunnerus.
13. *Coryphænoides carapinus*, Goode and Bean.
14. *Chalinura simula*, Goode and Bean.

BROTULIDÆ.

15. *Bassozetus normalis*, Gill, new species.

GADIDÆ.

16. *Phycis chuss*, (Walb.) Gill.
17. *Phycis tenuis*, (Mitch.) DeKay.
18. *Phycis regius*, (Walb.) Jordan and Gilbert.
19. *Phycis chesteri*, Goode and Bean.
20. *Haloporphyrus viola*, Goode and Bean.
21. *Merlucius bilinearis*, (Mitch.) Gill.
22. *Onos rufus*, Gill, new species.
23. *Onos cimbrius*, (Linn.) Goode and Bean.
24. *Gadus morrhua*, Linnæus.
25. *Brosmius brosme*, (Müller) White.
26. *Pollachius carbonarius*, Gill.

LYCODIDÆ.

27. *Lycodes verrillii*, Goode and Bean.
28. *Lycodon mirabilis*, Goode and Bean.
29. *Melanostigma gelatinosum*, Günther.

TRIGLIDÆ.

30. *Prionotus punctatus*, (Bloch) Cuv. and Val.
31. *Prionotus carolinus*, Günther.

AGONIDÆ.

32. *Peristedium miniatum*, Goode.
33. *Aspidophoroides monopterygius*, (Bloch) Storer.

COTTIDÆ.

34. *Hemitripterus americanus*, (Gmelin) Cuv. and Val.
35. *Cottus æneus*, Mitchill.
36. *Icelus uncinatus*, (Reinh.) Kroyer.
37. *Cottunculus microps*, Collett.

SCORPÆNIDÆ.

38. *Sebastes marinus*, (L.) Lütken.
39. *Sebastoplus dactylopterus*, (De la Roche) Gill.

CARANGIDÆ.

40. *Caranx pisquetus*, Cuv. and Val.

STROMATEIDÆ.

41. *Stromateus triacanthus*, Peck.

CORYPHÆNIDÆ.

42. *Coryphæna sueuri*, Cuv. and Val.

BERYCIDÆ.

- 43. *Plectromus suborbitalis*, Gill, new species.
- 44. *Stephanoberyx monæ*, Gill, new species.
- 45. *Caulolepis longidens*, Gill, new species.

SYNODONTIDÆ.

- 46. *Bathysaurus agassizii*, Goode and Bean.

ALEPOCEPHALIDÆ.

- 47. *Alepocephalus agassizii*, Goode and Bean.
- 48. *Alepocephalus productus*, Gill, new species.

HALOSAURIDÆ.

- 49. *Halosaurus macrochir*, Günther.
- 50. *Halosaurus goodei*, Gill, new species.

STOMIATIDÆ.

- 51. *Stomias ferox*, Reinhardt.
- 52. *Hyperchoristus tanneri*, Gill, new species.

STERNOPTYCHIDÆ.

- 53. *Sternoptyx diaphana*, Hermann.
- 54. *Argyropelecus hemigymnus*, Cocco.
- 55. *Cyclothone lusca*, Goode and Bean.

SCOPELIDÆ.

- 56. *Scopelus mülleri*, (Gmelin) Collett.

SYNAPHOBRANCHIDÆ.

- 57. *Synaphobranchus pinnatus*, (Gronow) Günther.
- 58. *Histiobranchus infernalis*, Gill, new species.

NEMICHTHYIDÆ.

- 59. *Nemichthys scolopaceus*, Richardson.
- 60. *Serrivomer beani*, Gill, new species.
- 61. *Spinivomer goodei*, Gill, new species.
- 62. *Labichthys carinatus*, Gill, new species.
- 63. *Labichthys elongatus*, Gill, new species.

NOTACANTHIDÆ.

- 64. *Notacanthus analis*, Gill, new species.
- 65. *Notacanthus phasganorus*, Goode.

XIPHIIDÆ.

66. *Xiphias gladius*, Linnæus.

CHAULIODONTIDÆ.

67. *Chauliodus sloani*, Bloch and Schneider.
68. *Sigmops stigmaticus*, Gill, new species.

LEPTOCEPHALIDÆ.

69. *Leptocephalus* sp. (larvæ of *Synaphobranchus*).

ANGUILLIDÆ.

70. *Conger oceanicus*, Gill.
71. *Simenchelys parasiticus*, Gill.

EURYPHARYNGIDÆ.

72. *Gastrostomus bairdii*, Gill and Ryder.

PETROMYZONTIDÆ.

73. *Petromyzon* (*Bathymyzon*) *bairdii*, Gill.
74. *Petromyzon marinus*, Linnæus.

MYXINIDÆ.

75. *Myxine glutinosa*, Linnæus.

CHIMÆRIDÆ.

76. *Chimæra abbreviata*, Gill, new species.

RAIIDÆ.

77. *Raia eglanteria*, Lacépède.
78. *Raia radiata*, Donovan.
79. *Raia ocellata*, Mitchill.
80. *Raia lævis*, Mitchill.

SPINACIDÆ.

81. *Squalus acanthias*, Linnæus.

GALEORHINIDÆ.

82. *Scoliodon terræ-novæ*, (Richardson) Gill.

SCYLLIIDÆ.

83. *Scyllium retiferum*, Gannan.

LOPHIIDÆ.

1. *Lophius piscatorius*, Linnaeus.*Lophius piscatorius*, Linn., Syst. Nat.; Günther, iii, 179.*Lophius americanus*, Cuv. and Val., xii, 380.

The stomach of each individual was examined, and generally contained *Phycis chuss* and *chesteri*. Specimens were found at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	19
2021	37 36 00	74 15 00	179
2057	42 01 00	68 00 30	86
2092	39 58 35	71 00 30	197
	41 07 30	71 07 00	*18

* Cox's Ledge.

MALTHIDÆ.

2. *Halientæa senticosa*, Goode.*Halientæa senticosa*, Goode, Proc. U. S. Nat. Mus., 1880, 467.

This species was collected at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2014	36 41 05	74 38 55	373
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 32 00	209
2092	39 58 35	71 00 30	197

PLEURONECTIDÆ.

3. *Monolene sessilicauda*, Goode.

Monolene sessilicauda, Goode, Proc. U. S. National Museum, iii, 1880, pp. 338, 472 (November 23).

This species was collected at the three following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2067	42 15 25	65 48 40	122
2086	40 05 05	70 35 00	69
2092	39 58 35	71 00 30	197

4. *Citharichthys arctifrons*, Goode.*Citharichthys arctifrons*, Goode, op. cit., pp. 341, 472 (November 23).

This species was obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2004	37 19 05	74 26 06	102
2014	36 41 05	74 38 55	373
2021	37 36 00	74 15 00	199
2032	39 29 00	72 19 40	74
2086	40 05 05	70 35 00	69
2087	40 06 50	70 34 15	65
2089	39 58 50	70 39 40	168

5. *Pleuronectes americanus*, Walbaum.*Pleuronectes americanus*, Walbaum, Artedi, Pisc., 1792, 113; Günther, iv, 443.*Platessa plana*, Storer, Fish. Mass., 373.

Specimens were found at the following stations:

Station.	North latitude.			West longitude.			Depth.
	°	'	"	°	'	"	
2020	37	37	50	74	15	30	143
2025	40	02	00	70	27	00	239
2027	39	58	25	70	37	00	198
2028	39	57	50	70	42	00	209
2053	40	02	00	68	27	00	105
2057	42	01	00	68	00	30	86
2061	42	10	00	66	47	45	115
2080	41	13	00	66	21	50	55
2081	41	10	20	66	30	20	50

6. *Glyptocephalus cynoglossus*, (Linn.) Gill.*Pleuronectes cynoglossus*, Linnæus, Syst. Nat., ed. x, i, 1758, p. 269.*Glyptocephalus cynoglossus*, Gill, Proc. Acad. Nat. Sci. Phila., 1873, p. 161;

Goode and Bean, Proc. U. S. Nat. Mus., i, 1878, p. 21 (with extensive synonymy); Goode, op. cit., p. 475.

Specimens were obtained at the following stations:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2004	37	19	05	74	26	06	98
2014	36	41	05	74	38	55	373
2018	37	12	22	74	20	04	788
2021	37	36	00	74	15	00	179
2030	39	29	45	71	43	00	588
2078	41	11	30	66	12	20	499
2086	40	05	05	70	35	00	69
2091	40	01	50	70	59	00	117
2092	39	58	35	71	00	30	197
2115	35	49	30	74	34	45	843

7. *Paralichthys dentatus*, (Linn.) Jordan & Gilbert.*Paralichthys dentatus*, J. & G., Bulletin U. S. Nat. Mus., No. 16, p. 822.*Pleuronectes dentatus*, L., Syst. Nat., i, 458.*Platessa ocellaris*, DeKay, N. Y. Fauna, Fish., 1842.*Pseudorhombus dentatus* and *P. ocellaris*, Günther, iv, 425-430.*Chænopssetta ocellaris*, Gill, Proc. Acad. Nat. Sci. Phil., 1864, 218.*Pleuronectes melanogaster*, Mitchell, Trans. Lit. and Phil. Soc. N. Y. (doubled example).*Platessa oblonga*, DeKay, N. Y. Fauna, Fish, 1842, 299, pl. 48, f. 156; not *Pleuronectes oblongus*, Mitch.*Pseudorhombus oblongus*, Günther, iv, 426.*Pseudorhombus dentatus*, Goode & Bean, Proc. U. S. Nat. Mus., 1879, 123.

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2079	41	13	00	66	19	50	75

8. *Paralichthys oblongus*, (Mitch.) Jordan & Gilbert.

Pleuronectes oblongus, Mitchill, Trans. Lit. and Phil. Soc., i, 391, 1815.

Platessa quadrocellata, Storer, Proc. Bost. Soc. Nat. Hist., 1847, 242, and in Hist. Fish. Mass., 397, pl. xxxi, f. 3.

This species was collected at the following stations, viz:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2025	40 02 00	70 27 00	239
2031	39 29 00	72 20 00	74
2087	40 06 50	70 34 15	65
2088	39 59 15	70 36 30	143

MACRURIDÆ.

9. *Macrurus bairdii*, Goode and Bean.

Macrurus bairdii, Goode & Bean, Amer. Jour. Sci. and Arts, xiv, 1877, pp. 471-473 (Massachusetts Bay); Cat. Fish Essex Co. and Mass. Bay, 1879, p. 7; Goode, Proc. U. S. Nat. Mus., iii, 1880, p. 475.

Numerous specimens were obtained from the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2014	36 41 05	74 38 55	373
2025	40 02 00	70 27 00	239
2028	39 57 50	70 42 00	209
2030	39 29 45	71 43 00	588
2036	38 52 40	69 24 40	1,735
2037	38 53 00	69 23 30	1,731
2039	38 19 26	68 20 20	2,369
2041	39 22 50	68 25 00	1,608
2053	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 22 00	141
2064	42 25 40	66 08 35	122
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2084	40 16 50	67 05 15	1,290
2092	39 58 35	71 00 30	197

10. *Macrurus carminatus*, Goode.

Macrurus carminatus, Goode, Proc. U. S. Nat. Mus., iii, 1880, pp. 346, 475 (Nov. 23).

Specimens were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2014	36 41 05	74 38 55	373
2020	37 37 50	74 15 30	143
2072	41 53 00	65 35 00	858
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

11. *Macrurus asper*, Goode & Bean.

Macrurus asper, Goode & Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix;
Report on the Fish, p. 19C.

Specimens of this rare species were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2001	37 46 30	74 00 00	499½
2072	41 53 00	65 35 00	838
2074	41 43 00	65 21 50	1,309
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451
2097	37 56 20	70 57 30	1,917
2098	37 40 30	70 37 30	2,221
2102	38 44 00	72 38 00	2,102
2103	38 47 20	72 37 00	1,091
2105	37 50 00	73 03 50	1,395
2106	37 41 20	73 03 20	1,497

12. *Coryphænoides rupestris*, Gunnerus.

Coryphænoides rupestris, Gunnerus, Thjemske, Selsk. Skr. 3, 1765, p. 50; Collett, Norges Fiske, p. 131.

Specimens were taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2003	37 16 30	74 20 36	641
2004	37 19 05	74 26 06	98
2035	39 26 16	70 02 37	1,362
3037	38 53 00	69 23 30	1,731
2041	39 22 50	68 25 00	1,608
2042	39 33 00	68 26 45	1,555
2051	39 41 00	69 20 20	1,106
2052	39 40 05	69 21 25	1,098

13. *Coryphænoides carapinus*, Goode and Bean.

Coryphænoides carapinus, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix; Report on the Fish.

Specimens were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451

14. *Chalinura simula*, Goode and Bean.

Chalinura simula, Goode and Bean, Bull. Mus. Comp. Zoöl., vol. x, No. 5, xix;
Report on the Fish., p. 199.

Specimens were obtained at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2037	38 53 00	69 23 30	1,731
2038	38 30 30	69 08 25	2,033
2043	39 49 00	68 28 30	1,467
2077	41 09 40	66 02 20	1,255
2084	40 16 50	67 05 15	1,290
2102	38 44 00	72 38 00	1,209
2103	38 47 20	72 37 00	1,091
2105	37 50 00	73 03 50	1,395
2116	35 45 23	74 31 25	888

BROTULIDÆ.

15. *Bassozetus normalis*, Gill, new species.*Bassozetus normalis*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 259.

One specimen was obtained at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2042	39 33 00	68 26 45	1,555

GADIDÆ.

16. *Phycis chuss*, (Walb.) Gill.*Blennius chuss*, Walbaum, Artedi, 1792, p. 186.*Phycis chuss*, Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 237.

This species occurred at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2003	37 16 30	74 20 36	641
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2021	37 36 00	74 15 00	179
-----	40 05 25	70 28 00	90
2025	40 02 00	70 27 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 42 00	209
2052	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 23 00	141
2078	41 11 30	66 12 20	499
2086	40 05 05	70 35 00	69
2087	40 06 50	70 34 15	65
2088	39 59 15	70 36 30	143
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
Cox ledge	41 07 30	71 07 00	18
2109	35 14 20	74 59 10	142

17. *Phycis tenuis*, (Mitch.) De Kay.*Gadus tenuis*, Mitchill, Trans. Lit. and Phil Soc. N. Y., 1814, p. 372.*Phycis tenuis*, De Kay, Zoöl. New York, Fishes, 1842, p. 293.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2021	37 36 00	74 15 00	179
2031	39 29 00	72 19 55	74
2053	40 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2085	40 05 00	70 34 45	70
2058	41 57 30	67 58 00	35
-----	40 01 50	70 39 20	111
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197
2109	35 14 20	74 59 10	142

18. *Phycis regius*, (Walb.) Jordan & Gilbert.*Blennius regius*, Walb., Art., Pisc., 1792, 186.*Phycis punctatus*, De Kay, N. Y. Fauna, Fish., 292.*Enchelyopus regalis*, Bloch & Schn., 1801, 53.*Phycis regalis*, Günther, iv, 355.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2021	37 36 00	74 15 00	179

19. *Phycis chesteri*, Goode and Bean.*Phycis chesteri*, Goode & Bean, Proc. U. S. Nat. Mus., i, 1878, p. 256; Cat.

Fish Essex Co. and Mass. Bay, 1879, p. 8; Goode, Proc. U. S. Nat. Mus., iii, p. 476.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2014	36 41 05	74 38 55	373
2025	40 02 00	70 22 00	239
2027	39 58 25	70 37 00	198
2028	39 57 50	70 42 00	209
2061	42 10 00	66 47 45	115
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197

20. *Haloporphyrus viola*, Goode & Bean.*Haloporphyrus viola*, Goode & Bean, Proc. U. S. Nat. Mus., i, pp. 257-260, Dec. 17, 1878.

Taken at the following stations:

Station.	North latitude.	West longitude.	Depth.
	° ' "	° ' "	
2030	39 29 45	71 43 00	588
2035	39 26 16	70 02 37	1,362
2051	39 41 00	69 20 20	1,106
2052	39 40 05	69 21 25	1,098
2072	41 53 00	65 35 00	858
2075	41 40 30	65 35 00	855
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2083	40 26 40	67 05 15	959
2084	40 16 50	67 05 15	1,290
2094	39 44 30	71 04 00	1,022
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451
2102	38 44 00	72 38 00	1,209
2103	38 47 20	72 37 00	1,091
2105	37 50 00	73 03 50	1,395
2111	35 09 50	74 57 40	938
2115	35 49 30	74 34 45	843
2116	35 45 23	74 31 25	888

21. *Merlucius bilinearis*, (Mitch.) Gill.*Stomodon bilinearis*, Mitchell, Rep. Fish. N. Y., 1814, p. 7.*Merlucius bilinearis*, Gill, Cat. Fish. E. Coast N. A., 1861, p. 48.

Taken in the following localities:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2014	36	41	05	74	38	55	373
2020	37	37	50	74	15	30	143
2025	40	02	00	70	27	00	220
2027	39	58	25	70	37	00	198
2052	42	02	00	68	27	00	105
2057	42	01	00	68	00	30	86
2058	41	57	30	67	58	00	35
2061	42	10	00	66	47	45	115
2081	41	10	20	66	30	20	50
2085	40	05	00	70	34	45	70
2086	40	05	05	70	35	00	69
2087	40	06	50	70	34	15	65
-----	40	01	50	70	39	20	111
2089	39	58	50	70	39	40	168
2090	39	59	40	70	41	10	140
2091	40	01	50	70	59	00	117
2092	39	58	35	71	00	30	197
-----	40	05	00	70	34	45	70

22. *Onos rufus*, Gill, new species.*Onos rufus*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 259.

Taken in the following localities:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2051	39	41	00	69	20	20	1,106
2072	41	53	00	65	35	00	858

23. *Onos cimbricus*, (Linn.) Goode & Bean.*Gadus cimbricus*, Linn., Syst. Nat., ed. xii, 1766, p. 440.*Onos cimbricus*, Goode & Bean, Proc. U. S. Nat. Mus., i, p. 349, Feb. 14, 1879.

Taken in the following locality:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2015	37	31	00	74	53	30	19

24. *Gadus morrhua*, Linnæus.*Gadus callarias et morrhua*, Linn., Syst. Nat.; Günther, iv, 328.*Morrhua americana*, Storer, Hist. Fish. Mass., 343.*Gadus macrocephalus*, Tiles., Mem. Acad. Sci., St. Petersburg, ii, 360, 1810.*Gadus macrocephalus*, Günther, iv, 330.*Gadus ogak*, Richardson, F. B. A., Fish, 246.*Gadus ogac*, Bean Bull. U. S. Nat. Mus., xv, 110.*Gadus auratus*, Cope, Proc. Am. Philos. Soc. Phila., 1873.

Taken in the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2057	42 01 00	68 00 30	86
2058	41 57 30	67 58 00	35
2061	42 10 00	66 47 45	115
----	41 07 30	71 07 00	*18

*Cox Ledge.

25. *Brosmius brosme*, (Müller) White.

Gadus brosme, Müller, Prodr. Zoöl., Dan., 41, 1776.

Gadus brosme, Fabr. Faun. Grœnl., 140.

Brosmius flavescens, Günther, iv, 369.

Brosmius flavescens, Storer, Fish. Mass., 368.

Brosmius brosme, Günther, iv, 369.

Brosmius vulgaris, De Kay, New York Fauna, Fish., 289.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2061	42 10 00	66 47 45	115
2064	42 25 40	66 08 35	122

26. *Pollachius carbonarius*, Gill.

Gadus virens and *G. carbonarius*, Linn., Syst. Nat.

Merlangus purpureus, Storer, Fish. Mass., 358.

Gadus virens, Günther, iv, 339.

Pollachius carbonarius, Gill.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2031	39 29 00	72 19 55	74

LYCODIDÆ.

27. *Lycodes verrillii*, Goode & Bean.

Lycodes verrillii, Goode & Bean, Amer. Jour. Sci. and Arts, vol. xiv, Dec., 1877, pp. 474-476.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2072	41 53 00	65 35 00	858
2094	39 44 30	71 04 00	1,022

28. *Lycodon mirabilis*, new species.*Lycodon mirabilis*, Goode & Bean, Bull. Mus. Comp. Zool., vol. x, No. 5.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2018	37 12 22	74 20 04	788
2037	38 53 00	69 23 30	1,731
2051	39 41 00	69 20 30	1,106
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2094	39 44 30	71 04 00	1,022
2105	37 50 00	73 03 50	1,395
2115	35 49 30	74 34 45	843
2116	35 45 23	74 31 25	888

29. *Melanostigma gelatinosum*, Günther.*Melanostigma gelatinosum*, Günther, Proc. Zool. Soc. London, 1881, part 1, Jan. 4, p. 21 (genus, p. 20), pl. ii, fig. A.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2001	37 46 30	74 00 00	519

TRIGLIDÆ.**30. *Prionotus punctatus*, (Bloch) Cuv. & Val.***Trigla punctata*, Bloch, Ansl. Fisch. taf., 352; ? Cuv. & Val., iv, 93; ? Günther, ii, 193; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 373.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2007	35 17 00	75 13 00	5

31. *Prionotus carolinus*, Günther.*Prionotus carolinus*, Günther, ii, 192.*Prionotus carolinus*, C. & V., iv, 90.*Prionotus palmipes* and *P. pilatus*, Storer, Fish. Mass., 18.*Prionotus pilatus*, Storer, Proc. Bost. Soc. Nat. Hist., ii, 77.? ? *Trigla carolina*, Linnæus, Mantissa, ii, 528.*Trigla palmipes*, Mitchell, Trans. Lit. and Phil. Soc. N. Y., i, 431, 1815.

Taken in the following locality:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2081	41 10 20	66 30 20	50

AGONIDÆ.

32. *Peristedium miniatum*, Goode.*Peristedium miniatum*, Goode, Proc. U. S. Nat. Mus., iii, pp. 349, 350, Nov. 23, 1880.

Taken at the following station (3 specimens):

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2004	37 19 05	74 26 06	98

33. *Aspidophoroides monopterygius*, (Bloch) Storer.*Cottus monopterygius*, Bloch, Ausl. Fisch., ii, 156; taf., 178; Günther, ii, 216.

Taken at the following localities:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2062	42 17 00	66 37 15	150
2064	42 25 40	66 08 35	122
2067	42 15 25	65 48 40	122
2079	41 13 00	66 19 50	75

COTTIDÆ.

34. *Hemitripteris americanus*, (Gmelin) Cuv. & Val.*Scorpaena americana*, Gmel., Syst. Nat., 1788, 1220.*Cottus acadian*, Walbaum, Artedi, Pisc., 1792, 392; Cuv. & Val., iv, 268; Günther, ii, 143.*Hemitripteris acadianus*, Storer, Hist. Fish. Mass., 35.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2083	42 02 00	68 27 00	105

35. *Cottus æneus*, Mitchill.*Cottus æneus*, Mitchill, Trans. Lit. & Phil. Soc. N. Y., i, 1815, 380; Goode & Bean, Bull. Essex Inst., 1879, 13.*Cottus mitchilli*, Günther, ii, 164.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2057	42 01 00	68 00 30	86
2058	41 57 30	67 58 00	35
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2063	42 23 00	66 23 00	141
2067	42 15 25	65 48 40	122
2081	41 10 20	66 30 20	50

36. *Icelus uncinatus*, (Reinh.) Kröyer.*Cottus uncinatus*, Reinh., Vid. Selsk. Natur. og Math., Afhandl. 1833, 44.*Centridermichthys uncinatus*, Günther, ii, 172.*Icelus uncinatus*, Kröyer, Naturh. Tidsskr. 1844, 253.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2068	42 03 00	65 48 40	131

37. *Cottunculus microps*, Collett.*Cottunculus microps*, Collett, Norges Fiske, Appendix to Forh. Vidensk. Selskab.

Christiania, 1874, p. 20, pl. 1, figs. 1-3; Norske Nordhavs-Expedition,

Fiske, 1880, p. 18, pl. 1, figs. 5 and 6.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2028	39 57 50	70 42 00	209
2030	39 29 45	71 43 00	588
2072	41 53 00	65 35 00	858
2078	41 11 30	66 12 20	499
2092	39 58 35	71 00 30	197
2115	35 49 30	74 34 45	843

SCORPÆNIDÆ.

38. *Sebastes marinus*, (L.) Lütken.*Perca marinus*, L., Syst. Nat., x, 1758, in part.*Perca norvegica*, Müller, Zöol. Dan., 46.*Sebastes norvegicus*, Günther, ii, 95.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2025	40 02 00	70 27 00	239
2053	42 02 00	68 27 00	105
2061	42 10 00	66 47 45	115
2067	42 15 25	65 48 40	122

39. *Sebastoplus dactylopterus*, (De la Roche) Gill.*Scorpena dactyloptera*, De la Roche, Ann. Mus., xiii, pl. 22, fig. 2 (*vide* Günther,

Cat. Fish. Brit. Mus., ii, p. 99).

Sebastoplus dactylopterus, Gill, M. S.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2061	42 10 00	66 47 45	115
2062	42 17 00	66 37 15	150
2088	39 59 15	70 36 30	143
2090	39 59 40	70 41 10	140
2092	39 58 35	71 00 30	197
2109	35 14 20	74 59 10	142

CARANGIDÆ.

- 40.
- Caranx pisquetus*
- , Cuv. & Val.; Cuv. & Val., ix, 97.

Caranx hippos, Holbr., Ichth. S. C., 1860, 90.*Paratractus pisquetus*, Gill, Proc. Acad. Nat. Sci. Phila., 1862, 432.*Caranx chrysos*, Günther, ii, 445.

Taken at the following station:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2107	35 19 30	75 15 20	16½

STROMATEIDÆ.

- 41.
- Stromateus triacanthus*
- , Peck; Peck, Mem. Amer. Acad., ii, 48.

Rhombus cryptosus, Cuv. & Val., ix, 408; Günther, ii, 398.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2102	38 44 00	72 38 00	1, 209

CORYPHÆNIDÆ.

- 42.
- Coryphæna sueuri*
- , Cuv. & Val.

Coryphæna sueuri, C. & V., ix, 302.*Coryphæna globiceps*, De Kay, N. Y. Fauna, Fish., 1842, 132.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2110	38 19 26 35 12 10	68 20 30 74 57 15	Surface; speared by grains. Do.

BERYCIDÆ.

- 43.
- Plectromus suborbitalis*
- , Gill, new species.

Plectromus suborbitalis, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2036	38 52 40	69 24 40	1, 735
2094	39 44 30	71 04 00	1, 022

- 44.
- Stephanoberyx monæ*
- , Gill, new species.

Stephanoberyx monæ, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2077	41 09 40	65 55 00	1, 253

45. *Caulolepis longidens*, Gill, new species.*Caulolepis longidens*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 258.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2034	39 27 10	69 56 20	1,346

SYNODONTIDÆ.**46. *Bathysaurus agassizii*, Goode & Bean.***Bathysaurus*, Günther, Ann. & Mag. Nat. Hist., Aug., 1878, p. 181.*Bathysaurus agassizii*, G. & B., Bull. Mus. Comp. Zool., Harvard College, vol. x, No. 5, p. 214.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2095	39 29 00	70 58 40	1,342
2105	37 50 00	73 03 50	1,395

ALEPOCEPHALIDÆ.**47. *Alepocephalus agassizii*, Goode & Bean.***Alepocephalus agassizii*, G. & B., Bull. Mus. Comp. Zool., Harvard College, vol. x, No. 5, p. 218.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2030	39 29 45	71 43 00	588
2051	39 41 00	69 20 20	1,106
2072	41 53 00	65 35 00	858
2075	41 40 30	65 35 00	855
2077	41 09 40	66 02 20	1,255
2078	41 11 30	66 12 20	499
2103	38 47 20	72 37 00	1,091

48. *Alepocephalus productus*, Gill, new species.*Alepocephalus productus*, Gill, Proc. U. S. Nat. Mus., vol. vi, pp. 256, 257.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2035	39 26 16	70 02 37	1,362

HALOSAURIDÆ.

49. *Halosaurus macrochir*, Günther.

Halosaurus macrochir, Günther, Ann. & Mag. Nat. Hist., 5th ser., ii, 1878, p. 251.

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2034	39 27 10	69 56 20	1,346
2050	39 42 50	69 21 20	1,050
2051	39 41 00	69 20 20	1,106
2052	39 40 05	69 21 45	1,098
2074	41 43 00	65 21 50	1,309
2077	41 09 40	66 02 20	1,255
2084	40 16 50	67 05 15	1,290
2095	39 29 00	70 58 40	1,342
2096	39 22 20	70 52 20	1,451
2102	38 44 00	72 38 00	1,209
2103	38 47 20	72 37 00	1,091
2106	37 41 20	73 03 20	1,497
2111	35 09 50	74 57 40	938
2116	35 45 23	74 31 25	888

50. *Halosaurus goodei*, Gill, new species.

Halosaurus goodei, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 257.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2035	39 26 16	70 02 37	1,362

STOMIATIDÆ.

51. *Stomias ferox*, Reinhardt.

Stomias ferox, Reinhardt, Vid. Selsk. Nat. og Math., Afhandl. x, p. lxxviii.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2095	39 29 00	70 58 40	1,342

52. *Hyperchoristus tanneri*, Gill, new species.

Hyperchoristus tanneri, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 256.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2083	40 26 40	66 58 00	956

STERNOPTYCHIDÆ.

53. *Sternoptyx diaphana*, Hermann.

Sternoptyx diaphana, Hermann, Naturforscher, xvi, p. 781, p. 8, Taf. i, figs. 1 and 2; xvii, p. 249 (copied by Walbaum, Artedi, iii, vol. i, figs. 1 and 2, and by Schneider, p. 494, pl. xxxv); Cuvier, Règne Animal, 2d ed., pl. xiii, fig. 1; Cuvier and Valenciennes Hist. Nat. Poiss., xxii, p. 415; Günther, Cat. Fish. Brit. Mus., v, p. 387 (no specimens).

Taken as follows:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2034	39	27	10	69	56	20	1,346
2036	38	52	40	69	24	40	1,735
2040	38	35	13	68	16	00	2,226
2044	40	00	30	68	37	20	1,067
2045	40	04	20	68	43	50	373
2047	40	02	30	68	49	40	389
2101	39	18	30	68	24	00	1,686
2102	38	44	00	72	38	00	1,209

54. *Argyropelecus hemigymnus*, Cocco.

Argyropelecus hemigymnus, Cocco, Giorn. Sc. Sic., 1829, fasc. 77, p. 146; Bonaparte, Faun. Ital. Pesc.; Cuv. and Val., Hist. Nat. Poiss., xxii, p. 398; Günther, Cat. Fish. Brit. Mus., v, p. 385.

Sternoptyx hemigymnus, Valenciennes in Cuvier, Règne Animal, Ill. Poiss., pl. 103, fig. 3.

Sternoptyx mediterranea, Cocco, Giorni il Faro, 1838, iv, p. 7, fig. 2; Bonaparte, Faun. Ital. Pesc., fig. —.

Taken as follows:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2043	39	49	00	68	28	30	1,467
2074	41	43	00	65	21	50	1,309
2075	41	40	30	65	35	00	855
2076	41	13	00	66	00	50	906
2101	39	18	30	68	24	00	1,686
2111	35	09	50	74	57	40	938

55. *Cyclothone lusca*, Goode & Bean.

Cyclothone lusca, Goode & Bean, Bull. Mus. Comp. Zoöl. Harvard College, vol. x, No. 5, p. 221.

Taken as follows:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2094	39	44	30	71	04	00	1,022
2095	39	29	00	70	58	40	1,342
2097	37	56	20	70	57	30	1,917
2099	37	12	20	69	39	00	2,949
2100	39	22	00	68	34	30	1,628
2101	39	18	30	68	24	00	1,686
2105	37	50	00	73	03	50	1,395
2106	37	41	20	73	03	20	1,497
2110	35	12	10	74	57	15	516

SCOPELIDÆ.

56. *Scopelus mülleri*, (Gmelin) Collett.*Salmo mülleri*, Gmelin's Linnaeus, Systema Naturæ, i, 1788, p. 1378.*Scopelus glacialis*, Reinhardt, Oversigt Kgl. D. Vid. Selsk. Nat. Math. Afh. vi, p. cx., Copenhagen, 1837.*Scopelus mülleri*, Collett, Norges Fiske, Tillaegsh. til. Forh. Vid. Selsk., Christiania, 1874, p. 152. Norske Nordhavs-Expedition, 1876-1878, Fiske, 1880, p. 158.

Taken as follows:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2001	37	46	30	74	00	00	499½
2002	37	20	42	74	17	36	641
2003	37	16	30	74	20	36	641
2014	36	41	05	74	38	55	373
2023	37	48	00	74	01	30	377
2034	39	27	10	69	56	20	1,346
2036	38	52	40	69	24	40	1,735
2039	38	19	26	68	20	20	2,369
2045	40	04	20	68	43	50	373
2047	40	02	30	68	49	40	359
2074	41	43	00	65	21	50	*1,309
2075	41	40	30	65	35	00	855
2076	41	13	00	66	00	50	906
2094	39	44	30	71	04	00	1,022
2097	37	56	20	70	57	30	1,917
2099	37	12	20	69	39	00	2,949
2100	39	22	00	68	34	30	1,628
2101	39	18	30	68	24	00	1,686

* Surface.

SYNAPHOBRANCHIDÆ.

57. *Synaphobranchus pinnatus*, (Gronow) Günther.*Muraena pinnata*, Gronow, Syst. ed. Gray, p. 19 (*vide* Günther).*Synaphobranchus pinnatus*, Günther, Cat. Fish. Brit. Museum, viii, p. 23.

Taken as follows:

Station.	North latitude.			West longitude.			Fathoms.
	°	'	"	°	'	"	
2002	37	20	42	74	17	36	641
2003	37	16	30	74	20	36	641
2025	40	02	00	70	27	00	239
2048	40	02	00	68	50	30	547
2072	41	53	00	65	35	00	*858
2075	41	40	30	65	35	00	855
2078	41	11	30	66	12	20	499
2083	40	26	40	67	05	15	959
2096	39	22	20	70	52	20	1,451
2115	35	49	30	74	34	45	843
2116	35	45	23	74	31	25	888
2110	35	12	10	74	57	15	516
2106	37	41	20	73	03	20	1,497

* In stomach of *Macrurus*,

58. *Histiobranchus infernalis*, Gill, new species.*Histiobranchus infernalis*, Gill, Proc., U. S. Nat. Mus., vol. vi, p. 255.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2037	38 30 30	69 08 25	1,731

NEMICHTHYIDÆ.

59. *Nemichthys scolopaceus*, Richardson.*Nemichthys scolopaceus*, Richardson, Voyage Samarang, Fishes, p. 35, pl. x, figs. 1, 3 (*vide* Günther, Cat. Fish. Brit. Mus., viii, p. 21).

Taken at the following stations:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2001	37 46 30	74 00 00	519
2002	37 20 42	74 17 36	641
2003	37 16 30	74 20 36	641
2023	37 48 00	74 01 30	377
2039	38 19 26	68 20 20	2,369

50. *Serrivomer beanii*, Gill, new species.*Serrivomer beanii*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 261.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2075	41 40 30	65 28 30	855

61. *Spinivomer goodei*, Gill, new species.*Spinivomer goodei*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 261.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2039	38 19 36	68 20 20	2,361

62. *Labichthys carinatus*, Gill, new species.*Labichthys carinatus*, Gill, Proc. U. S. Nat. Mus., vol. vi, pp. 261, 262.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2076	41 13 00	65 33 30	906

63. *Labichthys elongatus*, Gill, new species.

Labichthys elongatus, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 262.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
2100	° ' " 39 22 00	° ' " 68 34 30	1,628

NOTACANTHIDÆ.

64. *Notacanthus analis*, Gill, new species.

Notacanthus analis, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 255.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
2037	° ' " 38 30 30	° ' " 69 08 25	1,731

65. *Notacanthus phasganorus*, Goode.

Notacanthus phasganorus, Goode, Proc. U. S. Nat. Mus., iii, 535, 1880.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
2048	° ' " 40 02 00	° ' " 68 50 30	547

XIPHIIDÆ.

66. *Xiphias gladius*, Linnæus.

Xiphias gladius, Linn., Syst. Nat.; Günther, ii, 511; Storer, Fish. Mass, 1867, 71.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
2091	° ' " 40 01 50	° ' " 70 59 00	*117

* Trawl-line.

CHAULIODONTIDÆ.

67. *Chauliodus sloani*, Bloch & Schneider.

Chauliodus sloani, Bloch & Schn., 430; Günther, v, 392.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
2001	° ' " 37 46 30	° ' " 74 00 00	519
2002	37 20 42	74 17 36	641
2003	37 16 20	74 20 36	641
2094	39 44 30	71 04 00	1,022

68. *Sigmops stigmaticus*, Gill, new species.*Sigmops stigmaticus*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 256.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2039	38 19 26	68 20 20	2,361

LEPTOCEPHALIDÆ.**69. *Leptocephalus* sp. (perhaps larva of *Synphobranchus*).**

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2104	38 48 00	72 40 30	991

ANGUILLIDÆ.**70. *Conger oceanicus*, Gill.***Conger oceanicus*, Gill, Rept. Com. Fish for 1871-'72, 811.*Conger vulgaris*, Günther, viii, 38.*Conger occidentalis*, De Kay, N. Y. Fauna, Fish, 314, 1842.*Anguilla oceanica*, Mitchill, Jour. Acad. Nat. Sci., i, 407.*Conger vulgaris*, Cuvier, Règne Anim, 1817.*Muraena nigra*, Risso, Ichth. Nice, 1810, 93.*Anguilla conger*, L. Syst. Nat.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2011	36 38 30	74 40 10	81
2014	36 41 05	74 38 55	373
2031	39 29 00	72 19 55	74

71. *Simenchelys parasiticus*, Gill.*Simenchelys parasiticus*, Gill, MS. in Goode & Bean, Bull. Essex Inst., xi, 27, 1878.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2030	39 29 45	71 43 00	588

EURYPHARYNGIDÆ.

72. *Gastrostomus bairdii*, Gill and Ryder.*Gastrostomus bairdii*, Gill & Ryder, Proc. U. S. Nat. Mus., vol. vi, pp. 262-273.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2043	39 49 00	68 28 30	1,467
2047	40 02 30	68 49 40	389
2074	41 43 00	65 21 50	1,309
2096	39 22 20	70 52 20	1,451
2101	39 18 30	68 24 00	1,686

PETROMYZONTIDÆ.

73. *Petromyzon (Bathymyzon) bairdii*, Gill, Proc. U. S. Nat. Mus., vol. vi, p. 254.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2048	40 02 00	68 50 30	547

74. *Petromyzon marinus*, Linnæus.*Petromyzon marinus*, L. Syst. Nat.; Günther, viii, 501; Jordan, 348.*Petromyzon americanus*, Le Sueur, Trans. Am. Philos. Soc., i, 383.*Petromyzon americanus*, Storer, Fish. Mass., 251.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2048	40 02 00	68 50 30	547

MYXINIDÆ.

75. *Myxine glutinosa*, Linnæus.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2078	41 11 30	66 12 20	499
2086	40 05 05	70 35 00	69
2088	39 59 15	70 36 30	143
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

CHIMÆRIDÆ.

76. *Chimæra abbreviata*, Gill, new species.

Gill, Proc. U. S. Nat. Mus., vol. vi, p. 254.

Taken at one station.

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2084	40 16 50	66 58 00	1,290

RAIIDÆ.

77. *Raia eglanteria*, Lacépède.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2011	36 38 30	74 40 10	81
2015	37 31 00	74 53 30	19
*	40 05 25	70 28 00	90
2053	42 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
2089	39 58 50	70 39 40	168
2091	40 01 50	70 59 00	117
2092	39 58 35	71 00 30	197

* Trawl-line.

78. *Raia radiata*, Donovan.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2011	36 35 30	74 40 10	81
2015	37 31 00	74 53 30	19
2021	37 36 00	74 15 00	179
*	40 05 25	70 28 00	90
2053	42 02 00	68 27 00	105
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
2089	39 58 50	70 39 40	168
2092	39 58 35	71 00 30	197

* Trawl-line.

79. *Raia ocellata*, Mitchill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
.....	40 05 25	70 28 00	*90
2031	39 29 00	72 19 55	*74
2057	42 01 00	68 00 30	86
2081	41 10 20	66 30 20	50
(f)	41 07 30	71 07 00	18

* Trawl-line.

† Cox Ledge.

80. *Raia lævis*, Mitchill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
.....	40 01 50	70 39 20	111
2091	40 01 50	70 59 00	117

SPINACIDÆ.

81. *Squalus acanthias*, Linnæus.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
.....	40 05 25	70 28 00	*90
2031	39 29 00	72 19 55	†74
2032	39 29 00	72 19 40	74

* Trawl-line.

† Trawl-line and trawl.

GALEORHINIDÆ.

82. *Scoliodon terræ-novæ*, (Richardson) Gill.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2107	35 19 30	75 15 20	16½
2108	35 16 00	75 02 30	48

SCYLLIIDÆ.

83. *Scyllium retiferum*, Garman.

Taken as follows:

Station.	North latitude.	West longitude.	Fathoms.
	° ' "	° ' "	
2005	37 18 11	74 27 36	78½
2086	40 05 05	70 35 00	69
2091	40 01 50	70 59 00	117

GENERAL MEDICAL REPORT OF C. G. HERNDON, PASSED
ASSISTANT SURGEON, U. S. N.

The U. S. Fish Commission steamer Albatross was built in 1882 by the Pusey and Jones Company of Wilmington, Del. She is constructed of iron; is 234 feet in length over all, 200 feet on a 12-foot water line, $27\frac{6}{12}$ feet beam (molded), $16\frac{9}{12}$ feet depth, net registered tonnage 384; displacement on 12-foot draught, which is her usual draught when ready for sea, 1,000 tons. She is built on the water-tight compartment principle, having six iron bulkheads, five of which are water-tight; these bulkheads divide her into seven compartments, six of which are water-tight. Each bulkhead has a small gate in it, thus allowing, when necessary, water communication between the different compartments. By means of bilge connections, each compartment can be pumped out independently. The ship is supplied with two independent sets of compound engines, which drive right and left handed four bladed screws, and propel her at a maximum speed of 12 knots. The ship is rigged as a brigantine. Upon the main deck is the cabin, deck-house, and pilot-house. The cabin is 38 feet in length, extends across the width of the ship, is $7\frac{2}{12}$ feet below decks, and has a cubic capacity of 2,233 feet; on starboard side forward is an office, abaft this a state-room; corresponding to these on port side is a pantry and state-room; each of these state-rooms has a cubic capacity of 580 feet. In each state-room is an 11-inch circular air-port. Between these apartments is a passage-way 5 feet wide. Aft these is the main cabin. On each side of cabin are two circular air-ports, of same size as those in state-rooms. Cabin skylight is 6 by 5 feet. As in all other parts of ship, artificial light is furnished by the Edison incandescent system; heat is furnished by steam from main boilers, and ventilation by same apparatus as that in use in other parts of the ship. Between cabin and deck-house is a deck space the width of ship and 16 feet long. About center of this space is the ward-room skylight, 7 by 5 feet. The *deck-house*, the top of which forms the hurricane-deck, extends forward for 83 feet, is $13\frac{6}{12}$ feet wide and $7\frac{4}{12}$ feet high. It is built of iron, sheathed with wood as far as the forward fire-room bulkhead. This method of construction serves to protect what may be termed the uncovered hatchways. Forward the fire-room the deck-house is of wood; any hatch in this part can be securely battened down should the necessity arise. In the after part of the deck-house is the stairway leading to the ward-room; forward of this is the engine-room, lighted and ventilated by a door in each side, and a window to a side; the windows in the deck-house are 20 by 26 inches. The engine-room hatch has a windsail, and is $6\frac{2}{12}$ by $4\frac{6}{12}$ feet.

Around the sides and after end of the engine-room is an iron gallery,

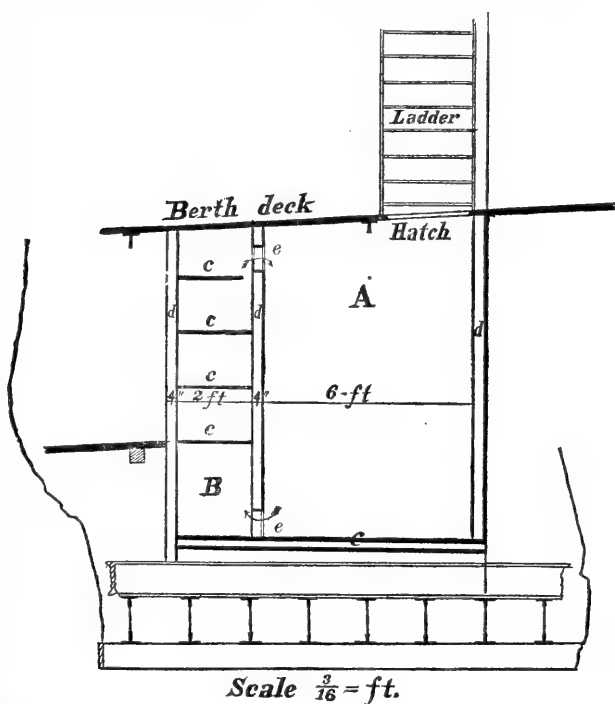
upon the forward port end of which is a Baird's distiller, capable of producing 2,000 gallons of water in twenty-four hours. Forward of the engine-room and immediately over the starting gear of the main engines is the kitchen, which contains a large and improved galley. Next to galley is the upper boiler-room, and forward of this are four state-rooms, two on each side, which are the quarters for members of the Fish Commission. These rooms are exceedingly well lighted and ventilated, each one having a large door and window opening from the gangway. Above each door are a number of apertures communicating with the outside air, and in cold and stormy weather, when doors and windows are closed, there is ample ventilation through these. In addition to these, the longitudinal bulkhead dividing the house has in its upper part perforations of considerable size and number. Cubic capacity of each of these rooms is 306 feet. Next comes the upper laboratory, which has the same beam as the rest of the house, is $13\frac{9}{12}$ feet long, and has a cubic capacity of 1,249 feet. A hatchway leads from this to lower or main laboratory. In after end of upper laboratory is a large bookcase for a scientific library. To the right of library is a case for scientific instruments, and on opposite side are two large tanks, one for alcohol and one for sea-water. On the starboard side of the forward bulkhead is the medical case, the upper part of which has large glass doors, and contains the dispensing bottles, measures, balance, &c. The lower portion of the case is filled with drawers, sufficient in number and size to contain the admirable outfit of medical and surgical instruments with which the Bureau of Medicine and Surgery has supplied this ship, and medical stores for six months' use. Prof. S. F. Baird has supplied the medical department of the ship with a number of the latest standard works on various medical and surgical subjects. In the center of the room is a large table directly under the skylight, at which four persons can be seated at one time. Along the sides of the room are three folding tables. This apartment is admirably lighted and ventilated by means of one hatch $6\frac{9}{12}$ by 5 feet, two windows and one door on each side. Immediately below the upper laboratory is the lower or main laboratory, of larger size than the former, as it extends from side to side of the ship, which here has a beam of 26 feet. It is 20 feet long and $7\frac{10}{12}$ feet between decks. This apartment, as well as the laboratory store-room immediately below, is separated from the rest of the ship by iron water-tight bulkheads, an important matter, as hundreds of gallons of alcohol are kept in them. The after end of this room contains a table for chemical work, and drawers for the storage of chemical apparatus. In the early part of the cruise repeated efforts were made to eliminate the constituent gases of sea-water by means of Behren's apparatus; but the apparatus, when set up, was so easily disarranged by even slight motion of the ship that the attempt was finally given up. The water specimens are now sent for analysis to the Fish Commission laboratories at Washington, D. C., and Wood's Holl, Mass.

The water to be preserved for analysis is brought up in the Sigsbee water-cup from various depths varying from a few fathoms to 2,747 fathoms, the greatest depth from which a specimen has yet been taken on board. As soon as the cup arrives at the surface its contents are poured into water-specimen bottles, with ground-glass stoppers, and over these split skin is carefully tied. Before the specimen bottles are used they are carefully washed out with distilled water. Many specimens of sea-water from varying depths and from various localities are examined on board in order to note the changes in specific gravity of the water under different conditions. The following scheme illustrates the method of recording the examinations:

Date.	Station.	Depth.	Temperature of the water at this depth.	Temperature of the air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60°.

At frequent intervals copies of the results of these examinations are forwarded to the Fish Commission laboratories. Hilgard's salinometer is the instrument used for determining the specific gravity. On the starboard side of the lower laboratory, aft, is a dark-room for the use of the photographer. On the port side, corresponding to this position, is a large sink supplied with running water, where specimens can be washed. Forward of the sink and dark-room are two long tables, where specimens can be sorted, dissected, &c.; the table on the port side, used by the ichthyologist, is of a convenient height for work while standing, that on the starboard side while seated. Each table is supplied with drawers, where instruments, towels, &c., can be kept. The forward bulkhead of lower laboratory is filled with compartment drawers for holding natural history specimen bottles. Below these drawers are spaces for eight boxes, which contain copper alcohol tanks, which hold 16 gallons. Laboratory store-room is just below. In this are kept large quantities of alcohol in tanks, natural history specimens ready for shipment, a large supply of specimen bottles ready for use, fishing-seines, scoop-nets, harpoons, &c. Forward of upper laboratory is the chart-room and pilot-house. On each side of deck-house is a gangway 6 feet wide. Forward of the pilot-house is the dredging engine, and beyond this a clear deck space in which is the berth-deck hatch. The forecastle is a high one, being 6 feet between decks. Under the forecastle on starboard side are closets for officers and bath-room for crew. On port side are closets for crew and lamp-room. The forecastle affords berths for fourteen of the crew. In cold and stormy weather at night a curtain is lowered from forecastle to main deck. Just below the berth-deck and forward of the forehold is a *cold-room and ice-house*.

The prime object in supplying the Albatross with these was to provide a place where fresh natural-history specimens could be stored and kept without undergoing putrefactive changes. When the cold-room is not in use for this purpose it can be used for the storage of fresh provisions, and has been so utilized during the past year. It is in this connection that I wish particularly to call attention to it, for it would be an easy matter to fit our naval vessels with similar compartments, and as new vessels for the Navy are now being constructed, and it seems not unlikely that more will soon follow, the present seems an opportune time to direct attention to the fact that in this ship these compartments have been in constant use for a year, and are now regarded by all as a practical success. The advantages resulting from the use of fresh food at sea need not be enumerated, and the benefits resulting from having a supply of ice on hand, not alone for dietetic purposes, but for use during the prevalence of many diseases, are equally recognized. The ice-house and cold-room are constructed to work on the cold-blast system. The ice-house and cold-room have the following dimensions: The former is 6 feet and the latter 2 feet in the clear, fore and aft. Each is about 9 feet high, and extends across the entire width of the ship. The ice-house, marked A in the appended figure, is divided



by a midship longitudinal bulkhead, making in fact two independent compartments, each capable of holding from 3 to 4 tons, according to the care with which the packing is done. The bulkheads,

top, sides, and bottom are double sheathed, and contain a 4-inch air space, which is filled with sawdust; they are lined on the inside with galvanized iron, and all joints are carefully soldered. A trap in each compartment drains all water into the bilge. The ice-houses are reached by hatches from the berth-deck. The cold-room B is immediately abaft the ice-house and communicates with it by apertures near the top and bottom of the after bulkhead of the ice-house, as shown by the arrows *e, e*. Gratings, *e, e, e, e*, which are in sections, and can be easily removed and cleaned, are used as shelves on which the natural history specimens or articles of food can be placed. The structure of the cold-room is precisely similar to that of the ice-house, except that the air-space is filled with hair-felt instead of sawdust. This space, just as in the ice house, is divided by a longitudinal bulkhead, thus allowing two independent compartments, each with its door in the after bulkhead. The air of the ice-house becomes chilled, falls to the bottom of the chamber, and precipitates its moisture, while the air in the cold-room, whose temperature is greater than that of the ice-house, and contains consequently more aqueous vapor, rises; thus a constant current is established between the chambers, and passes through the apertures marked by the arrows. That the air in the cold-room does take up and remove moisture has been shown by the simple experiment of placing wet cloths on the gratings, and which on removal a few hours later were found to be comparatively dry. Fresh food for twenty-five persons for twenty days has been carried, and this quantity could be largely increased. When the ice-house is kept well filled, the temperature of the cold-room is about 40° F.

Berth-deck.—On the forward part of this deck are the magazine, brig, &c. This deck is 40 feet long, $7\frac{1}{2}$ feet between decks, and has a cubic capacity of 16,000 feet; it is laid with yellow-pine lumber which was thoroughly seasoned before it was put into the ship, and consequently its capacity for absorbing and retaining moisture for hours after washing down is limited; the rapidity with which the deck dries can be greatly increased by starting the blowers immediately after drying down, and observations have shown that in a short time after starting these, the atmospheric conditions of berth and spar deck are alike. During the past year this deck has not been wet on an average more than twice a week. On this deck forty-four of the crew swing, and all the men are messed; they are provided with swinging tables and with benches, which can in a very short time be stowed away; the comfort of the crew is immensely promoted by the substitution of tables and benches for mess-cloths. The deck is well lighted and ventilated by two hatches, the larger of which is $6\frac{1}{2}$ by $6\frac{1}{2}$ feet, and a smaller one $3\frac{1}{2}$ by $3\frac{1}{2}$ feet; by four air-ports on each side, circular in shape, and 9 inches in diameter, and by six registers for artificial ventilation. Two steam-pipes, running to and from anchor and reeling engines, pass through this deck; their presence is sometimes an advantage and sometimes

not; in cold and wet weather they assist in keeping the deck dry and warm, but when the ship is at work in tropical climates they increase the temperature. The deck is supplied with two steam-heaters, and its average temperature is about 74° F. On the after part of this deck is the engine for reeling in the wire cable used in dredging operations.

The *steerage* is on the after part of the berth-deck; the apothecary, yeomen, and machinists live here. The steerage consists of a country $12\frac{2}{3}$ feet long and $7\frac{1}{2}$ feet between decks, and four state-rooms, two on a side; each state-room contains two bunks, one above the other; the bunks are 6 feet long. The cubic capacity of the steerage, country, and state-rooms is 2,184 feet. Each state-room has a circular air-port, 9 inches in diameter in the clear, and a register for artificial ventilation. The steam pipes for the anchor, dredging, and capstan engines pass through the steerage, and formerly made it very hot. This has been, to a very great degree, remedied by introducing through the main deck a 12-inch ventilator. The average temperature of these quarters prior to this, when steam was being used on forward engines, was 90° F., and the average now, under same conditions, is 80° F.

The *fire-room* is a very cool one, the average temperature during the year being only 90° F. The engine-room is cool, compared to many naval vessels; the hottest part is about the starting gear, which is just beneath the galley. The average temperature here for the year was 110° F.

The *ward-room* is 38 feet long and $7\frac{1}{2}$ feet between decks. It differs in plan from the usual ward-room in that forward of the state-rooms is a clear space, the entire width of the ship and $12\frac{3}{4}$ feet deep. Aft this space and on starboard side are three state-rooms and bath-room.

All bunks in this ship, except those in steerage, are $6\frac{1}{2}$ feet long. On port side are four state-rooms. Forward of ward-room, on starboard side, is the chief engineer's room, and on port side is the pantry, with a large store-room beneath. Under ward-room country are the paymaster's and navigator's store-rooms. Over forward part of ward-room is a hatch 7 by 5 feet. In the country are six registers for artificial ventilation, three on a side, and four circular air-ports, 9 inches in diameter, two on each side. Every state-room contains a register for artificial ventilation and one of the circular 9-inch air-ports. The cubic space of the country, state-rooms, and pantry is 4,300 feet. The average size of the state-rooms is 360 cubic feet.

Heating.—All parts of the ship are fitted with radiators supplied with steam from the main boilers.

Ventilation.—Ventilation is effected in part by the natural entrance of air through air-ports, doors, windows, and hatches, and largely by artificial means. The artificial ventilation is effected on the aspiration system by means of a No. 6 Sturtevant exhaust fan, propelled by a Wise steam motor, which is a kind of rotary machine, patented and manufactured by Thomas Wise, of South Framingham, Mass. The motor is

mounted on the fan-shaft without the intervention of any mechanism whatever. The plant is suspended from the under side of the main-deck beams in the boiler-room. The air-opening of the fan is circular, and has a diameter of 14 inches, which is the size of the main conduit. The two main branch conduits, one on each side of the ship, are 11 inches in diameter, and their branches, which run fore and aft the entire length of the ship, commence with a diameter of 9 inches, and diminish in size as they recede from the branch mains until a diameter of 3 inches is reached at the extremities of the hull. The registers are uniform in size, and have an opening of $2\frac{1}{2}$ inches. These openings are regulated by rotary covers on ground faces, whereby they are made air and water tight. The conduits are galvanized-iron spiral pipes, light, and strong enough to bear an internal pressure of 60 pounds. The pipe-joints are riveted and soldered. The system was designed to run at 1,018 revolutions per minute, and at that speed 251,500 cubic feet of air would have been exhausted from the ship, or a mean of 3,007 cubic feet per hour for each of the 75 persons on board. This, in actual practice, has not been realized, however, from lack of power in the motor driving the fan; in fact, not much more than half this volume has been reached. Notwithstanding this, the air in the inhabited parts of the ship is much better than it could possibly be without the artificial ventilation, and the comfort and health of all is thereby promoted. The vitiated air gathered from all parts of the ship is brought, by the system of pipes and conduits already described, to the upper part of the fire-room, where it is discharged with considerable force, and then mingles with the air entering the furnaces. Judging from my own experience during the past year, and from talking with various officers attached to the ship, I think there is but little doubt that the air between decks has been best, and every one has felt most benefit from the artificial ventilation, when the system has run continuously for hours at a time, thus preventing any accumulation of vitiated air, than when it has been run spasmodically, even though a higher rate of speed was maintained for a short time.

Lighting.—The ship is lighted by the Edison incandescent system, using a Z dynamo of 51 volts pressure, and requires about six horsepower from a steam-engine. The current of electricity flows through carbon filaments in vacuo, of 69 ohms resistance in lamps, each of which gives a light equal to 8 candles' power. Some 16-candle lamps are now in use on board. The total number of lamps in the ship is 140. Each state-room is supplied with one. The lamps are mounted on brackets and fixtures resembling gas-fixtures, and are lighted and extinguished by a key, which is much like the stop-cock on a gas jet. The lamps are guaranteed to last for 600 hours; many of those in this ship have been in use since the ship was commissioned, and have burned more hours than they were guaranteed to do. One of them has burned 1,590 hours; several have burned more than 1,200 hours, and the average life has

been 592 burning hours. This average would have been greater, but for the fact that the deck-house is abundantly supplied with lights, many of which are in very exposed positions, and have been accidentally broken long before their burning life was completed. This system of lighting has been to us a source of great comfort, so great, indeed, that it can only be properly appreciated by those who have used flickering candles in state-rooms, and who also know the difficulty with which ships' lamps, as a rule, are kept in good order. In addition to having a brilliant and steady light, it must be remembered that these lamps do not consume any of the oxygen of the air in the quarters below decks, which are necessarily restricted in cubic capacity, but leave it all for purposes of respiration.

In building the ship and in fitting her out neither expense nor pains were spared to make her a comfortable home for officers and men, and experience during the past year has shown her to be a comfortable and healthy ship. During 1883 the ship has been engaged in deep-sea explorations along the Atlantic coast from Cape Hatteras, N. C., to Cape Sable, Nova Scotia. The following ports were visited, several of them more than once: Washington, D. C.; Wilmington, Del.; Norfolk, Va.; New York, N. Y.; Greenport (L. I.), N. Y.; Newport, R. I.; Wood's Holl, Mass.; New Bedford, Mass.; Portsmouth, N. H.; Provincetown, Mass.; Gloucester, Mass.; Baltimore, Md. During the year she has steamed 10,416 miles, and was under steam 327 days. She was under steam, at sea, 108 days; in port, 257 days. There were 83 admissions to the sick-list; of these 77 were discharged to duty; 6 were invalided to the Washington and Norfolk naval hospitals; of these, 3 returned to duty on board and 3 were discharged from the service in the hospitals. One hundred and thirty-seven recruits were examined; of these, 110 were accepted and 27 rejected. The average number of souls on board for the year has been 67; of these, 9 are commissioned officers. There are no marines or apprentice boys in the ship's company.

NAVIGATION REPORT OF LIEUT. SEATON SCHROEDER, U. S. N., NAVIGATOR.

The cruising of the Albatross during this first year of service has been included between the parallels of 35° and 45° north latitude and the meridians of 64° and 77° west longitude. The number of days under way, the object of each trip, and the distances performed are given in the following table:

Date.	Object.	Miles.
December 30, 1882, to January 3, 1883..	Wilmington, Del., to Washington, D. C.	339.4
February 19 to February 14	Washington, D. C., to Wilmington, Del.	391.9
March 21 to March 25	Dredging	425.4
April 24 to May 9	Dredging and investigating migrations of mackerel.	1,476.6
May 19 to May 29	do	1,025.1
June 17 to June 19	New York to Washington, D. C.	426.1
July 6 to July 14	Investigating migrations of mackerel and menhaden.	816.2
July 18 to July 21	Dredging	446.6
July 25	Newport, R. I., to Wood's Holl, Mass.	40.0
July 26 to August 3	Dredging	682.8
August 7 to August 10	Investigating migrations of mackerel and menhaden.	423.8
August 12	Newport, R. I., to Wood's Holl, Mass.	40.0
August 13	Wood's Holl, Mass., to New Bedford, Mass.	24.0
August 18	New Bedford, Mass., to Wood's Holl, Mass.	24.0
August 21 to August 25	Investigating migrations of mackerel and menhaden.	951.1
August 29 to September 7	Dredging	859.5
September 11	Wood's Holl, Mass., to New Bedford, Mass.	24.0
September 13	New Bedford, Mass., to Wood's Holl, Mass.	24.0
September 20 to September 22	Dredging	263.6
September 30 to October 5	do	586.7
October 11	Wood's Holl, Mass., to Newport, R. I.	40.0
October 17 to October 19	Investigating migrations of mackerel and menhaden.	286.5
October 22 to October 25	do	411.7
November 5 to November 14	Dredging	1,020.3
December 28 to December 29	Washington, D. C., to Baltimore, Md.	180.0
Total, 121 days		11,228.2

The principal implements used in the navigation of the vessel comprise five box chronometers (three Negus, one Bliss & Creighton, and one Parkinson & Frodsham), one Negus pocket chronometer, four Ritchie liquid compasses (of which two are of the Navy Department design), one Rogers portable micrometer telescope, and one Walker's and one Bliss's patent log. These taffrail logs give perfect satisfaction if care is taken to keep them oiled and not to strike the propeller against the ship in hauling in; they constitute the only means used for measuring the speed of this ship through the water.

The standard compass was placed on top of the deck-house, 15½ feet forward of the smoke-stack, 3 feet 11 inches above the deck. Lieut. Commander T. A. Lyons, U. S. N., superintendent of compasses, Navy Department, had found this to be the position where the needle was least disturbed by the various magnetic forces exerted by the metal of and in the ship; it is also in a convenient position for use, being handy

for taking bearings and under the eye of the officer of the deck when under way.

In the month of April the local deviations were ascertained by azimuths of the sun taken on every point, the ship being upright and swung by the helm under steam. One circle was made with starboard helm and one with port helm, the mean of the results being accepted as correct. The curve of deviations for compass courses was plotted upon the Napier diagram, and a table of deviations for magnetic courses was deduced for convenience in laying the ship's head. In the accompanying steering card the points of the inner circle represent *correct magnetic* courses, which are joined by radiating curved lines to the corresponding *compass* courses at the outer circle.

Example.

To make a magnetic course east, steer by standard compass ESE. $\frac{1}{2}$ E.

The ship was also swung once while listed 4° to 6° to starboard and once while listed 4° to 6° to port, azimuths being taken on every alternate point. The greatest changes from the even-keel deviations were on the NNE. and SSW. courses, the deviations on those courses when listed to starboard being respectively $10^{\circ} 11'$ W. and $17^{\circ} 41'$ E., instead of $3^{\circ} 03'$ W. and $8^{\circ} 20'$ E., as on an even keel. When listed to port the deviations on these courses were $6^{\circ} 10'$ W. and $12^{\circ} 44'$ E., respectively, instead of $3^{\circ} 03'$ W. and $8^{\circ} 20'$ E., as on an even keel.

In general terms, it may be stated that the changes of deviations due to inclination are such that when heeled to starboard the ship's head is thrown to windward, or towards the higher side, when on any course in the northern semicircle; in the southern semicircle, when heeled to starboard, the ship's head is thrown to leeward, or towards the lower side.

When heeled to port the ship's head is thrown to leeward when on any course between southeast and northwest through north, and to windward when on any course to the southward of southeast and northwest.

At the same time that the ship was swung as above described, vibrations of vertical and horizontal needles at the position of the standard compass were observed on the various courses by Lieutenants Richard Wainwright and S. W. B. Diehl, U. S. N., on duty in the office of the superintendent of compasses, Navy Department, to obtain the mean values of λ and μ . The results of their observations will be published by the Bureau of Navigation, Navy Department.

This examination was made in latitude 38° N., off Point Lookout, at the mouth of the Potomac River, which ground affords every advantage in point of space and smooth water.

Lieutenants Wainwright and Diehl also made a magnetic survey of the vessel in the month of June, while in the dry-dock of the navy-yard, New York.

The ship's head, while building, was toward north, $29^{\circ} 30'$ W.; the ways were in latitude $39^{\circ} 44'$ N., longitude $75^{\circ} 33'$ W.

Of the chronometers on board, the Bliss & Creighton was loaned by the Navy Department, the Parkinson & Frodsham is the property of the commanding officer, and the Negus pocket chronometer, of the navigator. The box chronometers were placed under the lounge in the chart-room, the transporting cases being screwed to a false bottom on the deck. In this position they are secure from shocks, and the top of the lounge, opening and shutting on hinges, fits tightly enough to prevent any great changes of temperature. The lowest mean temperature between ratings during the year has been 57.4° F., and the highest 76° F. On deck the extremes have been 14° and 96° . The interval between ratings has usually been ten to twenty-five days.

The most powerful disturbing element on the rates of the chronometers has been the vibration of the hull caused by the dynamo engine, which is usually in operation from dark until 11 p. m. They appear to run equally well together while this vibration takes place every day, and during any material interval that it does not take place at all, but an interruption of either state of repose or vibration is almost invariably accompanied by a change in the second differences in the daily comparison book, showing that their rates are temporarily disturbed.

The dates of last cleaning of the chronometers are as follows: Bliss & Creighton, No. 1078, June, 1883; Parkinson & Frodsham, No. 1541, March, 1883; Negus, No. 1673, March, 1883; Negus, No. 1674, March, 1883; Negus, No. 1696, March, 1883; Negus, No. 3702 (pocket), October, 1880.

Ordinarily the Bliss & Creighton has been used for every-day work, the mean of all being taken when greater accuracy was required. On reaching port the chronometers are rated as soon as possible, and the errors corrected back if the discrepancy is greater than the probable limits of personal and instrumental errors of observation and plotting.

The Rogers portable micrometer telescope, loaned by the Bureau of Navigation, Navy Department, is a very reliable and a very useful instrument. A description and method of using it is to be found in the revised edition of Bowditch's Navigator, page 177. A modification of that method has been adopted in this vessel, by which less computation is required and the necessity is avoided of picking out each time the log. cotangent of such a small angle. It is as follows:

The greatest angle this instrument can measure is 1,750 micrometer divisions, or about $1^{\circ} 45'$, and it is seldom that an angle of over one-half or three-quarters of that is observed with it. In such small angles the functions may be considered as proportional to the arcs; that is, the cotangent of the angle measured is equal to the cotangent of one micrometer division divided by the number of those divisions. The log. cotangent of one division being accurately determined once for all, the rule for finding the distance is simply to add that function to the loga-

rithm of the height, and from the sum subtract the logarithm of the number of divisions.

The accuracy of this short method is shown in the following example, which is an extreme case :

Example.

A light-house 200 feet high is found to subtend an angle of 1,700 M. D. The value of one division of the instrument in this vessel is $3''.655$, of which the log. cotangent is 4.7515377, or in practice 4.75154.

Short method.

Rigorous method.

200 feet	log.	2.30103	$3''.655 \times 1,700 = 6,213''.5 = 1^\circ 43' 33''.5$.		
1 M. D.	log. cot.	4.75154	200 feet	log.	2.30103
			$1^\circ 43' 33''.5$	log. cot.	1.52097
		7.05257			
1,700 M. D	log.	3.23045	6,637.4 feet	log.	3.82200
6,639.3 feet	log.	3.82212			

The smaller the angle, of course the smaller will be the discrepancy.

For rapid work in a hydrographic survey or reconnaissance 10 feet is found to be a convenient length of staff to handle, and the logarithm of 10 being 1.00000, makes the computation all the easier. A board 10 inches broad, painted white, with a 2-inch black stripe down the middle, will be found to be an easily distinguished target.

In the navigation of the Albatross and the location of dredging and other stations, Sumner's method of finding the position at sea is used *in extenso*. All positions, however determined, are plotted as lines, and not as points, the intersection of two such lines, corrected for the intervening run and current, defining the exact position. The lines of position consist of portions of circles of equal altitude of the sun, moon, stars, and planets; parallels of latitude deduced from meridian or ex-meridian altitudes of the same bodies; lines of bearings of headlands or well-known objects on shore; circles of equal distance from known objects, found by micrometer or by their dipping below the horizon.

Whenever practicable, the errors of the chronometer are found by comparison with the time obtained by telegraphic connection with some observatory clock. When such connection is not feasible, equal altitudes of the sun are taken and computed by Chauvenet's method, either for apparent noon or apparent midnight.

The formula used for determining the latitude from the observed meridian altitude of any heavenly body is—

$$L = z + d.$$

For determining the latitude from an altitude near the meridian of any body, the following formula has always been used :

$$\cos z_0 = \sin h + \cos L \cos d \operatorname{versin} t,$$

in which the approximate value of L is used in computing the term

$\cos l \cdot \cos d \operatorname{versin} t$. A form and examples are to be found in Bowditch's Navigator, page 200. It does not appear in the revised edition.

The formula used for deducing the latitude from an altitude of Polaris, observed at any time, is—

$$L = h - p \cos t,$$

in which h = true altitude,

p = polar distance, expressed in minutes of arc,

t = hour angle = sidereal time — *'s R. A.

A form and example are to be found in the revised edition of Bowditch's Navigator, page 118. In practice, however, it has been found simpler to disregard the sign of $\cos t$, merely adding or subtracting the correction $p \cos t$, according as t is more than 6 and less than 18 hours, or the reverse.

For determining the circles of equal altitude of any body, the hour angle for each latitude is obtained from single altitudes by the ordinary formula—

$$\sin \frac{1}{2} t = \sqrt{\frac{\cos S \sin (S - h)}{\cos L \cos p}}$$

in which $S = \frac{1}{2} (h + L + p)$.

In addition to the above-mentioned methods, advantage is taken whenever possible of the simple problem of finding the exact distance from an object by reading the taffrail log when it bears exactly four points off the bow, and again when it bears exactly abeam; the distance from the object at the second bearing being equal to the distance run between the two plus or minus the current.

The current at each sounding is carefully estimated by noting the direction and speed of the ship necessary to keep the sounding wire vertical after the shot has passed below the surface current. A fair guide is thus afforded to what allowance should be made in shaping the course to the next position, as well as in connecting the run up to that point. Such help is particularly desirable when clouds by day, or clouds or the absence of the moon at night, prevent taking frequent observations.

Case I.—On April 28 single altitudes of the sun were observed at 6.43 a. m., 8.47 a. m., and 10.23 a. m., a sounding being taken at the time of each sight. The meridian altitude was observed at noon. The three time sights were worked out for latitudes $35^{\circ} 20' N.$ and $35^{\circ} 30' N.$, placing the vessel respectively on the lines AA, BB, CC (accompanying chart, see Plate); and the meridian altitude placed her in latitude $35^{\circ} 31' 35''$, DD. From the first sounding, ran 10 miles ESE. (mag.) to the second, where the temperature of the surface water and the current showed that the edge of the Gulf Stream had been reached. From the second to the third the drift in trawling and current were estimated at 3 knots NE. From the end of the third cast to noon the drift and current were about 2 miles NNE. These being plotted place the ship in the positions 1, 2, 3, 4.

Case II.—While sounding at about 7 a. m., May 1, a meridian altitude of the moon was observed, showing the latitude to be $36^{\circ} 41' 05''$ N. At the same time a single altitude of the sun was observed and worked out for latitudes $26^{\circ} 30'$ and $36^{\circ} 40'$. The ship was therefore at the intersection of the two lines thus found, AA, BB. While trawling two more sights of the sun were taken, at 10.09 and 10.49; and being worked out with the same latitudes as before, placed the ship on the lines CC, DD. Finally a meridian altitude of the sun was observed, which placed the ship in latitude $36^{\circ} 43' 54''$ at noon. EE. The drift while trawling, until the last time sight, was to NW., $2\frac{1}{2}$ to 3 knots in all; and then, after bearing in NW. by W. $\frac{1}{2}$ W., $2\frac{1}{4}$ miles to noon. No current noticeable. Plotting the track, the ship was found to have been in the positions 1, 2, 3, 4.

Case III.—At 3 and 5.45 p. m., August 1, single altitudes of the sun were observed and worked out for latitudes $39^{\circ} 40'$ N. and $39^{\circ} 50'$, giving lines AA and BB. At about 7.30 an altitude near meridian of \star Antares was taken, which placed the ship at that time on the parallel of $39^{\circ} 39' 23''$, line CC. The drift in trawling during the afternoon was SW., and the distance estimated at 4 knots between the first and second sights and $\frac{3}{4}$ to 1 knot from the second to the third. No current observed.

Whenever circumstances have been such as to warrant sufficient certainty in the position to give hydrographic value to the soundings taken, lists of them have been furnished to the Hydrographic Office of the Navy Department and the Coast and Geodetic Survey Office of the Treasury Department.

CONCLUSION OF THE YEAR'S WORK.

The work of refitting for our winter's cruise was commenced at once and pushed forward as rapidly as possible. There was but little to do, outside of the ordinary cleaning and painting, except in the engineer's department; there the work was mostly confined to the boilers, which continue to give us trouble.

Paymaster Charles D. Mansfield, U. S. N., reported for duty on the 15th, relieving Paymaster George H. Read.

Hon. W. E. Chandler, Secretary of the Navy, visited the ship on December 20 and inspected the vessel and scientific apparatus. The Naval Advisory Board and other prominent professional men also inspected the vessel and apparatus during her stay at the yard.

At 7.20 a. m., December 28, we left the navy-yard for Baltimore; arrived at 7.45 a. m. the following day, and made fast to the wharf at William Skinner & Son's Marine Railway. We expected to haul out at high water, between 8 and 9 a. m., but as the tide was unusually low, showing 3 feet below mean high water, this was impossible.

On Monday, December 31, there was ample water, and the vessel was taken up without delay. The condition of the submerged portion of the vessel's bottom was very good, considering the nature of the service and the length of time since she was docked.

The Roberts compound, furnished by Devoe & Co., was practically gone from the water-line down to the bilge keels; below this point it was in fair condition. In justice to the composition it should be mentioned that it was applied during very hot weather, and a large portion of it melted and ran off before the vessel was put into the water. The red-lead paint still covered the bottom except on the starboard side, where it had been scraped off by the dredge-rope, red rust forming rapidly on the bare spots thus left. Small barnacles were distributed quite thickly over the bottom, both on the compound and red lead; those growing on the compound were, however, not more than two-thirds the size of those found on the red lead, indicating that their growth had been resisted longer on the former surface or that the compound was less favorable to their development than the red lead.

The benefits derived from the use of the compound were not sufficiently apparent to induce us to continue its use. It is fair to say, however, that had it been applied in cooler weather it would probably have proved more satisfactory.

The bottom was thoroughly cleaned and given a coat of red lead, which was allowed to dry thoroughly; then a coat of white zinc was applied, and given time to dry before the vessel was put into the water.

The following officers were attached to the vessel at the conclusion of this report:

Commissioned officers.

Lieut.-Commander Z. L. Tanner, U. S. N., commanding.
 Lieut. Seaton Schroeder, U. S. N., executive officer and navigator.
 Lieut. S. H. May, U. S. N.
 Lieut. A. C. Baker, U. S. N.
 Ensign C. J. Boush, U. S. N.
 Ensign R. H. Miner, U. S. N.
 Passed Assistant Surgeon C. G. Herndon, U. S. N.
 Paymaster C. D. Mansfield, U. S. N.
 Passed Assistant Engineer G. W. Baird, U. S. N.

Petty officers.

Charles Wright, master-at-arms.
 G. B. Till, equipment yeoman.
 N. B. Miller, apothecary.
 G. A. Miller, paymaster's yeoman.
 F. L. Stailey, engineer's yeoman.
 S. M. McAvoy, machinist.
 John Hawkins, machinist.
 H. R. King, machinist.

Surgeon J. H. Kidder, U. S. N., was relieved April 18 by Passed Assistant Surgeon C. G. Herndon, U. S. N., and Paymaster George H. Read, U. S. N., was relieved by Paymaster C. D. Mansfield, U. S. N., on the 15th of November.

I.—*Dredging and trawling record, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., commanding, season of 1883.*

ABBREVIATIONS FOR KINDS OF BOTTOM.—C. for clay; g. for gravel; m. for mud; oz. for pebbles; s. for sand; sh. for shells; sp. for specks; st. for stones; blk. for black; blk. for broken; bu. for blue; crs. for coarse; dk. for dark; fine. for fine; glob. for Globigerina; gn. for green; gr. for gray; wh. for white; yl. for yellow.

Date.	Number of observer.	Locality.		Hour.		Temperatures.		Depth.	Kind of bottom.	Wind.		Drift.	Trawl used.
		Latitude north.	Longitude west.			Air.	Surface.			Direction.	Force.		
1883.								<i>Fathoms.</i>					
Mar. 22	2001	37 46 30	74 00 00	3, 22 p. m.		36	○	519	Gn. m.	NE.	3	NNW.	Deep-sea trawl.
23	2002	37 20 42	74 17 36	5, 50 a. m.		36	48	641	Gn. m.	N.	1	SSW.	Beam trawl.
23	2003	37 16 30	74 20 36	8, 44 a. m.		39	50	61		NE to E.	1	NW by W.	Do.
23	2004	37 19 45	74 25 06	10, 10 a. m.		45	51	102	Gn. m., sh.	ENE.	1	SW.	Do.
23	2005	37 18 11	74 27 36	11, 52 a. m.		43	50	82	Bu. m. and s., brk. sh.	ENE.	3	ENE.	Do.
23	2006	37 19 11	74 27 06	12, 38 p. m.		40	50	512	Bu. m., fine. s.	SSW.	4	W. by S.	Do.
27	2007	35 17 00	75 13 00	8, 00 a. m.		65½	68	15	Fne. s.	Var.	0-1	ENE.	Do.
27	2008	35 09 40	75 04 36	10, 15 a. m.		67	72	74½	Bu. m., fine. s.	W.	2-3	N. by E. ½ E.	Do.
28	2009	35 29 35	74 46 45	8, 45 a. m.		64	69	531		SW.	3	NE.	Deep-sea trawl.
28	2010	35 30 00	74 44 45	10, 40 a. m.		65	61	890		W. by S.	3	W. by S.	Do.
30	2011	36 38 30	74 40 10	9, 00 a. m.		47	48	81	S. and brk. sh.	N. by E.	3-4	N. by E.	Beam trawl.
30	2012	36 41 15	74 39 50	10, 15 a. m.		47	52	66½		NNE.	3-4	NNE.	Rake dredge.
30	2013	36 45 30	74 25 30	1, 05 p. m.		50	48	888	Gn. m.	NNE.	3	NW.	Beam trawl.
May 1	2014	36 41 05	74 38 55	6, 35 a. m.		51½	47	373	Gn. m., fine. s.	ENE.	4	ENE.	Do.
5	2015	37 31 00	74 53 30	8, 39 a. m.		49	48	19	Fne. s. and sh.	ENE.	3	N.	Do.
5	2016	37 31 00	74 52 36	9, 06 a. m.		48½	47	45½	Fne. s. and sh.	NE.	3	E. by N.	Deep-sea trawl.
5	2017	37 30 48	74 51 24	9, 50 a. m.		47½	46½	18		NE.	3	E. by N.	Do.
7	2018	37 12 23	74 20 04	12, 07 p. m.		62	54	788	Bu. m.	SW.	2		Rake dredge.
7	2019	37 13 52	74 23 52	4, 13 p. m.		56½	52½	39		SSW.	2		Deep-sea trawl.
21	2020	37 37 30	74 15 30	5, 30 a. m.		56	54	143	Bu. m., fine. s.	SE.	3	SW.	Beam trawl.
21	2021	37 36 00	74 15 00	7, 00 a. m.		58	54	179	Bu. m., fine. s.	SE.	3	W. by S.	Do.
21	2022	37 32 00	74 13 20	10, 00 a. m.		59	52	40		E.	3	SW by S.	Deep-sea trawl.
21	2023	37 48 00	74 01 30	3, 15 p. m.		62	56	377	Bu. m.	SE.	3	NE.	Beam trawl.
25	2024	40 02 10	70 27 00	5, 51 a. m.		52	49	222	Dk. gn. m., fine. s.	NNW.	2	NW by N.	Do.
25	2025	40 02 00	70 27 00	7, 20 a. m.		57	49	299	Gn. m., fine. s.	NNW.	2	NW by N.	Do.
25	2026	40 04 00	70 28 50	9, 00 a. m.		58	48	131	Gn. m. and s.	NNW.	2	NW ½ N.	Do.
25	2027	39 58 25	70 37 00	12, 21 p. m.		56	52	198	Bu. m.	SW.	3	WSW.	Do.
25	2028	39 57 30	70 32 00	2, 05 p. m.		56	52	41	Bu. m.	SW.	3	WSW.	Do.
25	2029	39 42 00	70 47 00	5, 13 p. m.		57	53	1, 108	Gy. m.	SW.	3-4	WSW.	Dredge tangles.
26	2030	39 29 45	71 43 00	6, 20 a. m.		56	49	588	Bu. m.	SW.	2	SW ½ W.	Beam trawl.
26	2031	39 29 00	72 19 55	1, 05 p. m.		55	50	49½	Gy. m., blk. and wh. s.	SSW.	3-4	SE.	Do.
26	2032	39 29 00	72 19 40	2, 10 p. m.		55	50	74	Gy. m., fine. s., blk. sp.	SSW.	3-4	S.	Do.
26	2033	39 32 30	72 18 35	5, 00 p. m.		62	40½	379	Gn. m.	SSW.	0-1	ENE.	Do.
July 17	2034	39 27 10	69 56 20	8, 55 a. m.		69	72	1, 346	Glob. oz.	Var.		WSW.	Do.

I.—Dredging and trawling record, U. S. Fish Commission steamer *Albatross*, Lieutenant-Commander Z. L. Tanner, U. S. N., &c.—Continued.

Date.	Number of observations.	Locality.		Hour.	Temperature.		Depth.	Kind of bottom.	Wind.		Drift.		Trawl used.
		Latitude north.	Longitude west.		Air.	Surface.			Direction.	Force.	Direction.	Distance.	
1883. July	2035	39 26 16	0 0 0	2.50 p. m.	73	71	1,362	Glob. oz.	SE.	2	SE.	Miles.	Beam trawl.
	2036	38 52 40	69 24 40	4.30 a. m.	82	76	1,735	Glob. oz.	SE.	2	S.	3.8	Do.
	18	38 53 00	69 23 30	1.22 p. m.	79	76	1,731	Glob. oz.	SE.	2	E.	3.7	Do.
	26	38 30 30	69 08 25	2.32 p. m.	77	76½	2,033	Glob. oz.	NE.	4	NE.	7.5	Deep-sea trawl.
	28	38 19 26	68 20 20	Noon.	77½	81	2,369	Glob. oz.	S.	1	S.	11	Do.
	29	38 35 13	68 16 00	4.20 a. m.	76	76	2,226	Glob. oz.	SSW.	6	S. by E.	10	Do.
	30	39 22 50	68 25 00	3.15 a. m.	71	72	1,608	Glob. oz.	NW.	3	NW.	10	Do.
	30	39 22 50	68 26 45	10.32 a. m.	74	71	1,555	Glob. oz.	NW.	4	NW.	12	Do.
	30	39 49 00	68 28 30	5.07 p. m.	71	72	1,467	Glob. oz.	W.	3	SW.	9	Do.
	31	40 04 20	68 37 20	5.25 a. m.	71	72	1,067	Oz.	W.	2	NW.	7	Do.
	31	40 04 20	68 43 50	10.00 a. m.	75	72	40	Bu. m., fine sh.	W.	2	WNW.	2.5	Beam trawl.
	31	40 02 49	68 49 00	Noon.	74	72	40	Bu. m.	W.	3	WNW.	2.5	Do.
	31	40 02 49	68 49 40	2.15 p. m.	74	72	52	Bu. m.	W.	3	WNW.	2.5	Deep-sea trawl.
	1	40 02 00	68 50 30	3.56 p. m.	73	72	29½	Crs. s., m., and g.	W.	3	ENE.	2	Do.
	1	39 43 40	69 20 00	3.35 a. m.	71	71	1,025	Bu. m.	W.	4	W.	3	Do.
	1	39 42 50	69 21 20	9.15 a. m.	72	72	44½	Glob. oz.	SW.	3	SW. by S.	3.5	Beam trawl.
	1	39 40 05	69 21 25	2.34 p. m.	74	72	39	Glob. oz.	SW. by W.	2	SW.	4	Do.
	1	42 02 60	68 27 00	5.00 a. m.	60	61	1,098	Glob. oz.	SW. by W.	2	SW. by W.	3	Do.
	29	42 03 30	68 26 00	6.20 a. m.	56	64	105	Bu. m.	ESE.	5	NE. by N.	1.4	Beam trawl.
	29	42 32 00	68 17 00	9.24 a. m.	60	60	99.5	Bu. m., s., and crs. g.	E.	6	NE. by N.	1.5	Dredge.
	30	42 01 30	68 01 00	3.23 p. m.	58	57	97	Bu. m., fine s., and crs. g.	E.	3	WSW.	1	Do.
	30	42 01 30	68 00 30	4.26 p. m.	58	57	86	Crs. s., blk. sp., brk. sh.	NE.	2	S.	2	Beam trawl.
	30	41 57 30	67 58 00	6.39 p. m.	58	58	35	Gy. s.	NNE.	2	SW.	1	Do.
	31	42 05 00	66 46 15	5.00 a. m.	56	55	41	Bu. m. and s.	ENE.	3	SSW.	2	Do.
	31	42 10 00	66 47 15	7.10 a. m.	56	55	123	Gy. s., blk. sp., brk. sh.	ENE.	4	W.	1.5	Do.
	31	42 10 00	66 47 45	8.00 a. m.	58	54	40	Gy. s., blk. sp., bu. m.	NNE.	3	NW. by W.	1.5	Do.
	31	42 17 00	66 37 15	10.47 a. m.	64	61	42	S. and g.	NE.	3	NE. by N.	1.5	Do.
	31	42 23 00	66 23 00	1.26 p. m.	60	57½	141	S. and crs. g.	ENE.	3	SE.	1	Do.
	31	42 25 40	66 08 35	4.32 p. m.	58	56	122	Crs. s. and g.	N.	2	SE.	1	Do.
	31	42 27 00	66 00 45	7.00 p. m.	60	55	80	S., g., and brk. sh.	N.	2	SE. by E.	1	Rake dredge.
Sept.	1	42 19 40	65 49 30	5.00 a. m.	54	54	65	S., s., and g.	NE.	3-4	ENE.	1.5	Do.
	1	42 15 25	65 48 40	7.05 a. m.	56	46	122	S. and g.	NE.	4	ENE.	2	Beam trawl.
	1	42 03 00	65 48 40	10.03 a. m.	60	56	42	S., fine g., and o.	ESE.	4	E.	2	Do.
	1	41 54 50	65 48 35	1.34 p. m.	61	56½	131	S., s., g., p., and o.	NE.	5	E. by N.	1.5	Grapnel dredge.
	1	41 55 30	65 47 10	2.58 p. m.	61	57	113	P. and o.	E.	5	N.	1	Bar and tangles.
	1	41 56 20	65 48 40	4.10 p. m.	61	57	113	P. and o.	ENE.	5	N.	1	Grapnel dredge.
	1	41 56 20	65 48 40	4.10 p. m.	61	57	113	P. and o.	ENE.	5	N.	1	

2	2072	41 53 00	65 35 00	6.15 a.m.	70	56	39	858	Gy. m	S.	Beam trawl.
2	2073	41 54 15	65 39 00	10.41 a.m.	71	58	40	586.5	Gy. s	SW.	Do.
2	2074	41 43 00	65 21 50	6.42 a.m.	71	69	41	309	M. and st.	WSW.	Do.
3	2075	41 40 30	65 35 00	3.41 p.m.	58	39	885		Glob. oz	NW.	Do.
3	2076	41 13 00	66 00 50	3.20 t.m.	59	69	906		Bu. m.	NE.	Do.
4	2077	41 09 40	66 02 20	8.00 a.m.	57	68	39	1,255	Bu. m. and s	NW.	Do.
4	2078	41 11 30	66 12 20	8.40 p.m.	60	66	40	1,499	Gy. m. and s	W.	Do.
4	2079	41 13 00	66 19 50	4.15 p.m.	60	67½	45	75	W.h. s	NW.	Do.
4	2080	41 13 00	66 21 50	5.10 p.m.	60	67½	45	55	Gy. s	WSW.	Do.
4	2081	41 10 20	66 30 20	6.50 p.m.	59	56	46	50	W.h. s, blk. sp.	NW. by W.	Do.
4	2082	41 09 50	66 31 50	6.50 p.m.	58	55	46½	49	Crs. yf. s	NW. by W.	Do.
5	2083	40 26 40	67 05 15	4.30 a.m.	73	72	40	959	Gy. m	SW.	Do.
5	2084	40 16 50	67 05 15	9.09 a.m.	73	78½	40	1,290	Bu. m. and s	SW.	Do.
20	2085	40 05 00	67 05 15	6.56 a.m.	67	68	50	70	Bu. m.	E.	Do.
20	2086	40 05 05	70 35 00	9.20 a.m.	70	67	52½	65	Bu. m., gy. s	N. by E.	Do.
20	2087	40 06 50	70 34 15	10.30 a.m.	71	67	50½	69	Bu. m., wh. s	NE. ¼ E.	Do.
20	2088	39 59 15	70 36 30	12.40 p.m.	68	68	48	143	Yf. s	NNE.	Do.
20	2089	39 58 50	70 39 40	3.13 p.m.	69	45	168		Gy. s	S. by W.	Do.
20	2090	39 59 40	70 41 10	4.40 p.m.	71	68	48½	140	Gy. s, brk. sh	E.	Do.
21	2091	40 01 50	70 59 00	7.50 a.m.	68	69	49	117	Gn. m.	ENE.	Do.
21	2092	39 58 35	71 00 30	7.50 a.m.	74	67½	45	197	Gn. m.	E.	Do.
21	2093	39 42 50	71 01 20	1.12 p.m.	75	69	39	1,000	Foraminifera, s. m.	E.	Do.
21	2094	39 44 30	71 04 00	5.07 p.m.	70	68	38½	1,022	Foraminifera, s. m.	NE.	Do.
30	2095	39 22 20	70 52 40	9.02 a.m.	71½	69½	37½	1,342	Glob. oz.	S.	Do.
30	2096	39 22 20	70 52 40	9.02 a.m.	70	69	37½	1,451	Glob. oz.	SW.	Do.
1	2097	37 56 20	70 57 30	5.30 p.m.	73	72½	37½	1,917	Glob. oz.	S ½ W.	Do.
1	2098	37 40 30	70 37 30	1.08 p.m.	73	72½	37½	2,221	Glob. oz.	W. by S.	Do.
2	2099	37 12 20	69 39 00	5.30 a.m.	71	82	37½	2,949	Glob. oz.	SSW.	Do.
3	2100	39 22 60	68 34 30	1.05 a.m.	63	69	37	1,628	Glob. oz.	SE.	Do.
3	2101	39 18 30	68 24 30	4.31 p.m.	61	67	37	1,686	Glob. oz.	WNW.	Do.
5	2102	38 44 20	72 38 00	6.53 a.m.	64	62½	39	1,209	Glob. oz.	Var.	Do.
5	2103	38 47 20	72 37 00	11.14 a.m.	67	62	39	1,091	Glob. oz.	S.	Do.
5	2104	38 48 00	72 40 30	3.41 p.m.	67	63	41½	991	Bu. m.	SSW.	Do.
5	2105	37 50 00	73 03 50	6.06 a.m.	63	63	41	1,395	Glob. oz.	SSE.	Do.
6	2106	37 41 20	73 03 20	Meridian.	66	63	42½	1,497	Glob. oz.	S	Do.
6	2107	35 19 30	75 15 20	8.23 a.m.	71	76	78½	163	Fne. dk. gy. s, small sh.	S by W.	Do.
9	2108	35 16 00	75 02 30	11.00 a.m.	76	76	78½	48	Bu. m., crs. s	S.	Do.
9	2109	35 14 20	74 59 10	1.03 p.m.	74	76	50½	142	Bu. m.	S by W.	Do.
9	2110	35 12 10	74 57 15	2.50 p.m.	76	75½	40	516	Bu. m.	S.	Do.
9	2111	35 10 50	74 57 40	5.25 p.m.	75	76	70	938	Gn. m.	S. by W.	Do.
10	2112	35 09 50	75 18 00	9.15 a.m.	70	76	73½	153	S, blk. sp	S.	Do.
10	2113	35 20 30	75 19 00	10.04 a.m.	72	70	72½	15	M, blk. s	SW.	Do.
10	2114	35 20 00	75 20 00	11.15 a.m.	73	70	72	14	M, blk. s	SW.	Do.
11	2115	35 49 30	74 34 45	7.54 a.m.	77	78	39	843	M, fne. s	SW. by S.	Do.
11	2116	35 45 23	74 31 25	Meridian.	76	77	39	888	Bu. m., fne. s	S. by W.	Do.

III.—*Specific gravities of sea-water, U. S. Fish Commission steamer Albatross, by Passed Assistant Surgeon C. G. Herndon, U. S. N., 1883.*

Date.	Station.	Depth of the sea.	Depth at which the water was taken.	Temperatures at these depths.	Temperature.	Specific gravity.	Corrected to 60° F.
		<i>Fathoms.</i>	<i>Fathoms.</i>	°	°		
July 17, 1883	2034	1, 280	Surface.	71	64	1.026	1.026548
Do	2034		100	44	62	1.0265	1.026770
Do	2034		200	41	61	1.0265	1.026630
Do	2034		300	40.5	61	1.027	1.027130
Do	2034		400	39.5	61	1.027	1.027180
Do	2034		500	40	61	1.0275	1.027630
Do	2034		600	40	61	1.0275	1.027630
Do	2034		700	39.5	61	1.0275	1.027630
Do	2034		800	40	60	1.028	1.028000
Do	2034		900	39	60	1.0285	1.028500
Do	2034		1, 000	39.75	60	1.030	1.030000
Do	2035		Surface.	73	65	1.026	1.026690
Do	2035		5	71	65	1.026	1.026690
Do	2035		10	69.5	62	1.0265	1.026770
Do	2035		15	52.5	60	1.027	1.027000
Do	2035		20	48	60	1.027	1.027000
Do	2035		25	50	60	1.027	1.027000
Do	2035		40	46	60	1.027	1.027000
July 18, 1883	2036	1, 735	Surface.	75	75	1.026	1.028265
Do	2036		5	74	75	1.026	1.028265
Do	2036		10	72	73	1.0265	1.028424
Do	2036		15	68	71	1.027	1.028606
Do	2036		20	65	70	1.027	1.028445
Do	2036		25	60	65	1.027	1.027690
Do	2036		40	60	65	1.028	1.028690
Do	2036		600	39.75	60	1.028	1.028000
Do	2036		700	39.5	60	1.028	1.028000
Do	2036		800	39	60	1.028	1.028000
Do	2036		900	38.5	60	1.028	1.028000
Do	2036		1, 000	38.5	60	1.028	1.028000
Do	2036		1, 100	38.5	60	1.028	1.028000
Do	2036		1, 200	40.5	60	1.029	1.029000
Do	2037	1, 731	Surface.	76	76	1.026	1.028432
Do	2037		5	74	76	1.026	1.028432
Do	2037		10	73	75	1.027	1.028265
Do	2037		15	66	70	1.027	1.027145
Do	2037		20	63	68	1.027	1.028136
Do	2037		25	62	66	1.027	1.027840
Do	2037		40	61	65	1.028	1.028690

IV.—*Temperature and density of sea-water from August 31 to November 11, 1883.—U. S. Fish Commission steamer Albatross.*

Date.	Station.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
			°	°	°		
August 31, 1883	2064	Surface.	54	58	82	1.0218	1.025320
Do	2064	5	53	58	81	1.0222	1.025539
Do	2064	10	53	58	81	1.0222	1.025539
Do	2064	15	53	58	81	1.0222	1.025539
Do	2064	20	49.5	58	81	1.0222	1.025539
Do	2064	25	53	58	81	1.0222	1.025539
Do	2064	40	51.5	58	81	1.0224	1.025739
Do	2064	60	44	58	81	1.0225	1.025839
Do	2064	100	42.5	58	80	1.0232	1.026360
September 1, 1883	2071	Surface.	55	58	82	1.0220	1.025520
Do	2071	5	55	58	81	1.0220	1.025339
Do	2071	10	55	58	81	1.0220	1.025339
Do	2071	15	55	58	81	1.0220	1.025339

IV.—Temperature and density of sea-water, &c.—Continued.

Date.	Station.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
September 1, 1883.....	2071	20	54	58	81	1.0224	1.025739
Do.....	2071	25	52.5	58	81	1.0224	1.025739
Do.....	2071	40	53	58	81	1.0224	1.025739
Do.....	2071	60	41.5	58	81	1.0226	1.025939
Do.....	2071	100	43	58	81	1.0226	1.025939
September 20, 1883, 11 a. m.....	2087	Surface.	69	71	70	1.0252	1.026650
September 20, 1883.....	2087	5	68	71	70	1.0252	1.026650
September 20, 1883, 2 p. m.....	2088	Surface.	69	70	70	1.0252	1.026650
September 20, 1883.....	2088	5	68	70	70	1.0252	1.026650
September 20, 1883, 6 p. m.....	2090	Surface.	69	67	70	1.0251	1.026550
September 20, 1883.....	2090	5	68	67	70	1.0251	1.026550
September 21, 1883, 10 a. m.....	2092	Surface.	69	70	70	1.0253	1.026750
September 21, 1883.....	2092	5	68.25	70	71	1.0252	1.026806
September 21, 1883, 4 p. m.....	2093	Surface.	69	70	70	1.0250	1.026450
September 21, 1883.....	2093	5	68	70	70	1.0250	1.026450
September 21, 1883, 9 p. m.....	2094	Surface.	69	66	77	1.0240	1.026618
September 21, 1883.....	2094	5	65	66	75	1.0242	1.026465
September 30, 1883, 12 m.....	2095	Surface.	69	71	71	1.0251	1.026706
September 30, 1883.....	2095	5	67	71	71	1.0251	1.026706
September 30, 1883, 6 p. m.....	2096	Surface.	70	70	72	1.0251	1.026864
Do.....	2096	5	67.5	70	72	1.0251	1.026864
Do.....	2096	10	68	70	72	1.0251	1.026864
Do.....	2096	15	68	70	72	1.0252	1.026964
Do.....	2096	20	67	70	71	1.0253	1.026906
Do.....	2096	25	66	70	67	1.0257	1.026637
Do.....	2096	40	57.5	70	67	1.0264	1.027387
Do.....	2096	60	55.5	70	67	1.0266	1.027587
Do.....	2096	100	55.5	70	84	1.0236	1.027512
Do.....	2096	200	47	70	85	1.0235	1.027600
Do.....	2096	300	40.5	70	85	1.0235	1.027600
Do.....	2096	400	40	70	85	1.0235	1.027600
Do.....	2096	500	40	70	85	1.0235	1.027600
Do.....	2096	600	39.5	70	86	1.0233	1.027616
Do.....	2096	700	39.5	70	85	1.0235	1.027600
Do.....	2096	800	38.5	70	85	1.0236	1.027700
Do.....	2096	900	39	70	86	1.0235	1.027816
Do.....	2096	1,000	34.5	70	86	1.0235	1.027816
October 1, 1883, 10 a. m.....	2097	Surface.	69	73	75	1.0253	1.027565
Do.....	2097	5	68	73	75	1.0253	1.027565
October 2, 1883, 10 a. m.....	2098	Surface.	74	77	76	1.0248	1.027532
Do.....	2098	5	72	77	76	1.0248	1.027232
October 3, 1883, 10 a. m.....	2101	Surface.	68	72	75	1.0246	1.026865
Do.....	2101	5	73	72	69	1.0248	1.026724
November 5, 1883, 11 a. m.....	2102	Surface.	63	64	61	1.0266	1.027148
November 5, 1883, 3 p. m.....	2103	Surface.	64	67	65	1.0264	1.027090
November 5, 1883, 7 p. m.....	2104	Surface.	63	62	64	1.0266	1.027148
Do.....	2104	5	62	62	63	1.0264	1.026811
Do.....	2104	10	62	62	63	1.0264	1.026811
Do.....	2104	15	62	62	65	1.0262	1.026890
Do.....	2104	20	62	62	63	1.0263	1.026711
Do.....	2104	25	62	62	63	1.0266	1.027011
Do.....	2104	40	59	62	64	1.0264	1.026948
Do.....	2104	60	55	62	62	1.0270	1.027270
Do.....	2104	100	53.5	62	59	1.0276	1.027480
Do.....	2104	200	43.5	62	57	1.0274	1.027040
Do.....	2104	300	40.5	62	57	1.0274	1.027040
Do.....	2104	400	40	62	57	1.0274	1.027040
Do.....	2104	500	40	62	56	1.0273	1.026820
Do.....	2104	600	39.5	62	57	1.0273	1.026840
Do.....	2104	700	39	62	57	1.0272	1.026840
Do.....	2104	800	—	62	57	1.0273	1.026940
Do.....	2104	900	39	62	57	1.0273	1.026940
November 6, 1883, 11 a. m.....	2105	Surface.	62	67	65	1.0260	1.026690
November 6, 1883, 6 p. m.....	2106	Surface.	62	62	66	1.0260	1.026840
Do.....	2106	5	62	62	64	1.0262	1.026748
Do.....	2106	10	62	62	65	1.0262	1.026890
Do.....	2106	15	62	62	64	1.0263	1.026848
Do.....	2106	20	62	62	64	1.0263	1.026848
Do.....	2106	25	62.5	62	64	1.0263	1.026848
Do.....	2106	40	54	62	63	1.0265	1.026911
Do.....	2106	60	49.5	62	60	1.0267	1.026700
Do.....	2106	100	51.5	62	60	1.0270	1.027000

IV.—*Temperature and density of sea-water, &c.*—Continued.

Date.	Station.	Depth.	Temperature by attached thermometer.	Temperature of the air.	Temperature at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
November 6, 1883, 6 p. m	2106	200	43. 5	62	58	1. 0272	1. 026960
Do	2106	300	41	62	58	1. 0272	1. 026960
Do	2106	400	39. 5	62	58	1. 0272	1. 026960
Do	2106	500	39. 5	62	58	1. 0272	1. 026960
Do	2106	600	39	62	58	1. 0274	1. 027160
Do	2106	700	39	62	58	1. 0274	1. 027160
Do	2106	800	39	62	58	1. 0274	1. 027160
Do	2106	900	38. 5	62	58	1. 0274	1. 027160
Do	2106	1, 000	37	62	57	1. 0275	1. 027140
November 9, 1883, 10 a. m	2107	Surface.	62	76	79	1. 0250	1. 027983
November 9, 1883, 12.30 p. m	2108	Surface.	78	74	78	1. 0252	1. 028008
November 9, 1883, 2 p. m	2109	Surface.	76	75	78	1. 0252	1. 028008
November 9, 1883, 5 p. m	2110	Surface.	76	75	77	1. 0254	1. 028018
November 9, 1883, 10 p. m	2111	Surface.	76	76	77	1. 0253	1. 027918
November 10, 1883, 12 m	2114	Surface.	71	74	73	1. 0250	1. 026924
November 11, 1883, 11 a. m	2115	Surface.	78	74	78	1. 0252	1. 028008
November 11, 1883, 5 p. m	2116	Surface.	78	75	74	1. 0256	1. 027686
Do	2116	5	77	75	74	1. 0256	1. 027686
Do	2116	10	77	75	75	1. 0255	1. 027765
Do	2116	15	77	75	75	1. 0255	1. 027765
Do	2116	20	77	75	75	1. 0255	1. 027765
Do	2116	25	77	75	75	1. 0255	1. 027765
Do	2116	40	68. 5	75	75	1. 0255	1. 027765
Do	2116	60	69	75	75	1. 0256	1. 027865
Do	2116	100	40	75	75	1. 0256	1. 027865
Do	2116	200	45	75	73	1. 0254	1. 027324
Do	2116	300	41	75	74	1. 0249	1. 026986
Do	2116	400	40	75	75	1. 0250	1. 027265
Do	2116	500	40	75	75	1. 0252	1. 027465
Do	2116	600	39	75	75	1. 0252	1. 027465

V.—*Meteorological record on board the U. S. Fish Commission steamer Albatross, from April 24 to May 27, and from September 29 to October 4, 1883.*

Date.	Barometer.		Air.				Surface water.		State of sea.	Wind.		State of weather.	
			Dry bulb.		Wet bulb.								
	Max.	Min.	Max.	Min.	Max.	Min.							
April 24, 1883	30.14	29.88	44	40	44	40	o	o	Smooth		Variable	0-3	Overcast and rainy.
April 25, 1883	30.28	30.16	51	38	52	38	52	49	Smooth		NW. and SSE	1-5	Clear and pleasant.
April 26, 1883	30.44	30.24	68	46	61	45	53	49	Smooth		SW. to ENE	0-2	Do.
April 27, 1883	30.22	30.04	70	52	65	52	75	49	Smooth		W. and SSW	0-2	First part clear, second part overcast.
April 28, 1883	30.04	29.90	68	55	65	55	70	51	Smooth		SW. to W	0-3	Clear, hazy about horizon.
April 29, 1883	30.08	29.82	64	44	63	44	57	46	Smooth, then moderate		S. and NNE	1-7	Clear during forenoon, then overcast and rainy.
April 30, 1883	30.42	30.08	80	45	73	44	48	45	Moderate		NNE. to ENE	1 to 6	Clear and pleasant.
May 1, 1883	30.42	30.30	54	47	53	46	51	46	Smooth		NNE. to ENE	1 to 3	Passing clouds.
May 2, 1883	30.26	30.14	52	47	52	48	51	45	Moderate		NE	1-6	Cloudy.
May 3, 1883	30.19	30.11	48	46	48	46	50	45	Moderate, then rough, then long swell.		NNW. to E	1-6	Cloudy and foggy.
May 4, 1883	30.24	30.16	63	45	55	45	50	45	Smooth		E. and SSE	1-2	Do.
May 5, 1883	30.26	30.16	63	49	62	40	50	46	Moderate		ENE. to N	1-6	Do.
May 6, 1883	30.24	30.14	68	49	65	49	65	47	Long swell		WNW. to ENE	1-3	Foggy at first, afterwards clearing.
May 7, 1883	30.30	30.18	61	50	58	50	58	48	Long swell		Var. and SW. to S	0-3	Clear and pleasant.
May 8, 1883	30.16	30.08	71	53	68	52	62	48	Smooth		South	1-3	Do.
May 9, 1883	30.22	30.10	96	67	89	65	73	62	Smooth		S. to SW	1-2	Do.
May 10, 1883	30.30	30.19	86	66	84	65	73	64	Smooth		SW. to SE	1-3	Do.
May 11, 1883	30.16	30.08	76	66	76	66	71	68	Smooth		SSW. to WSW	0-3	Clear; passing clouds.
May 12, 1883	30.16	30.10	87	56	82	56	69	65	Smooth		NW. to NE	0-2	Clear and pleasant.
May 13, 1883	30.20	30.08	83	56	75	54	70	66	Smooth		N. by E	0-1	Do.
May 14, 1883	30.20	29.90	78	56	74	56	70	65	Smooth		E. to SW	0-4	Passing clouds.
May 15, 1883	29.86	29.60	85	65	77	62	73	69	Smooth		S. to NW	1-3	Do.
May 16, 1883	30.18	29.84	95	54	82	53	68	61	Smooth		NW. to NNE	1-3	Clear and pleasant.
May 17, 1883	30.38	30.18	76	49	69	49	68	60	Smooth		N. to NE	1-2	Do.
May 18, 1883	30.42	30.32	83	46	73	46	71	53	Smooth		NW. to E. by N	0-2	Do.
May 19, 1883	30.30	30.00	57	53	54	50	57	48	Rough		NE	2-6	Do.
May 20, 1883	29.98	29.76	57	51	57	53	56	50	Moderate, long swell		NNW	1-2	Cloudy and foggy.
May 21, 1883	29.72	29.58	59	55	63	55	61	48	Long swell		SE	1-3	Overcast and foggy.
May 22, 1883	29.70	29.54	64	55	62	52	56	50	Moderate, long swell		SE	2-4	Passing clouds and foggy.
May 23, 1883	29.82	29.71	61	50	60	50	62	48	Long swell		ENE. to SSW	2-4	Do.
May 24, 1883	30.08	29.82	63	51	60	50	53	49	Smooth		WSW. to SW	2-5	Clear and pleasant.
May 25, 1883	30.24	30.08	58	49	58	49	53	46	Smooth		NNW. to SW	1-3	Do.
May 26, 1883	30.18	29.92	68	54	62	54	52	49	Smooth		SW. to SSW	3-4	Do.

V.—Meteorological record on board the U. S. Fish Commission steamer *Albatross*, &c.—Continued.

Date.	Barometer.		Air.				Surface water.		State of sea.	Wind.		State of weather.
			Dry bulb.		Wet bulb.							
	Max.	Min.	Max.	Min.	Max.	Min.						
May 27, 1883	29.88	29.78	75	55	75	55	65	51	Smooth	SW. to S	1-5	Overcast, gradually clearing.
September 29, 1883	30.32	30.18	71	56	69	56	64	57	Smooth	E. to NW. to S	1-3	Passing clouds.
September 30, 1883	30.18	29.92	72	64	72	64	70	60	Smooth	S. to SSW	2-4	Do.
October 1, 1883	30.06	29.86	80	66	78	65	75	71	Moderate	SSW. to NW. to NE	2-4	Do.
October 2, 1883	30.10	29.76	82	67	81	65	83	76	Rough	NE. to SE. to SW	2-8	Passing clouds ; squally.
October 3, 1883	30.12	29.76	78	61	77	57	82	67	Rough	NNW. to WNW	3-7	Do.
October 4, 1883	30.36	30.12	64	45	62	43	66	55	Rough, then moderate	NNW. to WNW	4-7	Clear and pleasant.

VI.—Record of speed of 5 trawlings and soundings, July, 1883, U. S. Fish Commission steamer Albatross, Lieutenant-Commander Z. L. Tanner, U. S. N., commanding.

TRAWL—GOING DOWN.

Fathoms.	Number of station.				
	2038.	2039.	2040.	2041.	2042.
	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>
Surface to 100	4 00	5 15	7 20	3 55	4 00
100 to 200	5 00	4 05	4 10	4 30	4 00
200 to 300	5 00	3 50	3 15	4 00	3 45
300 to 400	4 00	4 00	4 25	4 30	5 30
400 to 500	4 40	5 30	9 05	4 30	3 55
500 to 600	4 00	4 45	4 15	4 46	3 30
600 to 700	4 00	3 53	4 00	4 45	3 30
700 to 800	5 20	4 02	3 30	4 47	5 00
800 to 900	4 45	4 15	4 00	4 45	4 00
900 to 1,000	4 10	4 00	3 40	4 47	4 30
1,000 to 1,100	4 05	7 35	4 20	4 47	4 00
1,100 to 1,200	4 50	6 15	3 40	5 05	4 00
1,200 to 1,300	9 20	7 25	4 15	4 20	4 10
1,300 to 1,400	6 00	5 00	4 15	4 20	4 10
1,400 to 1,500	5 50	5 00	3 40	4 20	4 00
1,500 to 1,600	4 30	4 30	4 40	4 30	4 20
1,600 to 1,700	4 30	4 30	4 35	4 40	4 10
1,700 to 1,800	6 00	4 00	7 40	4 25	4 15
1,800 to 1,900	5 15	8 00	6 20	4 20	3 50
1,900 to 2,000	4 15	11 45	5 25	4 10	3 40
2,000 to 2,100	5 05	7 45	5 00	4 10	3 45
2,100 to 2,200	5 00	7 50	5 10	4 10	.....
2,200 to 2,300	4 35	7 00	7 00	*2 00	.....
2,300 to 2,400	4 20	5 00	6 15	.....	.....
2,400 to 2,500	4 00	5 00	7 00	.....	.....
2,500 to 2,600	9 30	6 45	6 45	.....	.....
2,600 to 2,700	5 30	4 50	4 00	.....	.....
2,700 to 2,800 .....	.....	5 00	3 40	.....	.....
2,800 to 2,900 .....	.....	9 55	4 00	.....	.....
2,900 to 3,000 .....	.....	5 00	3 40	.....	.....
3,000 to 3,100 .....	.....	4 20	.....	.....	.....
3,100 to 3,200 .....	.....	6 15	.....	.....	.....
Total time	2 17 30	3 02 15	2 28 40	1 40 32	1 26 00
Average speed per 100 fathoms	5 05	5 42	4 57	4 28	4 06
Depth in fathoms	2,033	2,369	2,226	1,608	1,555

* To 2,250 fathoms.

TRAWL—COMING UP.

100 to surface	4 30	5 15	6 00	4 40	3 25
200 to 100	4 00	3 45	3 00	4 40	3 25
300 to 200	4 00	4 00	3 31	4 40	3 25
400 to 300	5 55	5 30	3 31	4 40	3 25
500 to 400	4 00	4 00	3 31	4 40	3 25
600 to 500	4 00	3 30	3 31	4 40	3 25
700 to 600	2 40	4 00	3 31	4 40	3 20
800 to 700	4 15	3 45	3 31	5 45	3 20
900 to 800	3 30	4 00	3 31	4 30	3 20
1,000 to 900	3 00	4 00	3 31	4 25	3 45
1,100 to 1,000	3 00	3 45	3 32	4 55	5 00
1,200 to 1,100	4 00	4 30	4 35	5 10	4 00
1,300 to 1,200	3 30	4 15	4 00	6 15	5 00
1,400 to 1,300	3 30	4 55	4 00	7 00	5 45
1,500 to 1,400	4 00	4 25	4 00	7 00	5 45
1,600 to 1,500	4 15	3 55	4 00	10 00	5 45
1,700 to 1,600	9 00	3 30	3 25	6 45	6 05
1,800 to 1,700	5 00	4 00	3 40	6 48	7 48
1,900 to 1,800	4 45	4 00	4 15	6 48	7 48
2,000 to 1,900	5 00	4 00	10 05	6 48	7 47
2,100 to 2,000	4 30	4 00	5 45	6 48	7 47
2,200 to 2,100	4 30	4 00	5 25	6 45	.....
2,300 to 2,200	4 30	4 00	5 50	5 45	.....
2,400 to 2,300	5 00	4 00	5 30	.....	.....
2,500 to 2,400	4 00	5 00	6 10	.....	.....
2,600 to 2,500	5 00	4 30	12 30	.....	.....
2,700 to 2,600	6 00	4 40	6 45	.....	.....
2,800 to 2,700 .....	.....	4 25	6 45	.....	.....
2,900 to 2,800 .....	.....	5 00	8 30	.....	.....

VI.—Record of speed of 5 trawlings and soundings, July, 1883, &c.—Continued.

TRAWL—COMING UP—Continued.

Fathoms.	Number of station.				
	2038.	2039.	2040.	2041.	2042.
	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>	<i>h. m. s.</i>
2,900 to 3,000.....	.....	5 10	7 00	.....	.....
3,000 to 3,100.....	.....	6 15	.....	.....	.....
3,100 to 3,200.....	.....	10 15	.....	.....	.....
Total time.....	2 00 20	2 24 15	2 32 50	2 14 10	1 40 45
Trawl on bottom.....	1 14 30	1 47 30	2 37 20	1 51 25	1 26 50
Average speed per 100 fathoms.....	4 27	4 30	5 05	5 44	4 48

SOUNDING—GOING DOWN.

Surface to 100.....	1 02	0 57	1 30	1 20	1 00
100 to 200.....	0 56	0 55	1 30	1 20	0 55
200 to 300.....	0 57	1 00	1 30	1 20	4 00
300 to 400.....	1 00	0 46	1 30	1 20	6 30
400 to 500.....	1 02	0 58	1 30	1 20	1 25
500 to 600.....	1 02	1 02	1 30	1 15	1 03
600 to 700.....	1 07	1 00	1 30	1 25	1 17
700 to 800.....	1 09	1 02	1 30	1 18	1 15
800 to 900.....	1 08	1 00	1 30	1 22	1 25
900 to 1,000.....	1 16	1 07	1 30	1 17	1 20
1,000 to 1,100.....	1 14	1 06	1 30	1 23	1 25
1,100 to 1,200.....	1 17	1 04	1 30	1 21	1 25
1,200 to 1,300.....	1 07	1 08	1 30	1 19	1 30
1,300 to 1,400.....	1 17	1 10	1 30	1 20	1 25
1,400 to 1,500.....	1 16	1 11	1 30	1 20	*1 00
1,500 to 1,600.....	1 15	1 14	1 30	†0 24	.....
1,600 to 1,700.....	1 22	1 05	1 00	.....	.....
1,700 to 1,800.....	1 28	1 12	1 45	.....	.....
1,800 to 1,900.....	2 40	1 18	1 20	.....	.....
1,900 to 2,000.....	†3 33	1 15	1 30	.....	.....
2,000 to 2,100.....	.....	1 15	1 20	.....	.....
2,100 to 2,200.....	.....	1 20	§0 20	.....	.....
2,200 to 2,300.....	.....	||1 00	.....	.....	.....
Total time.....	27 08	24 05	31 15	19 30	26 55
Average speed per 100 fathoms.....	1 21	1 01	1 21	1 13	1 43
Depth in fathoms.....	2,033	2,369	2,226	1,608	1,555

* To 1,480 turns.

† To 1,942 turns.

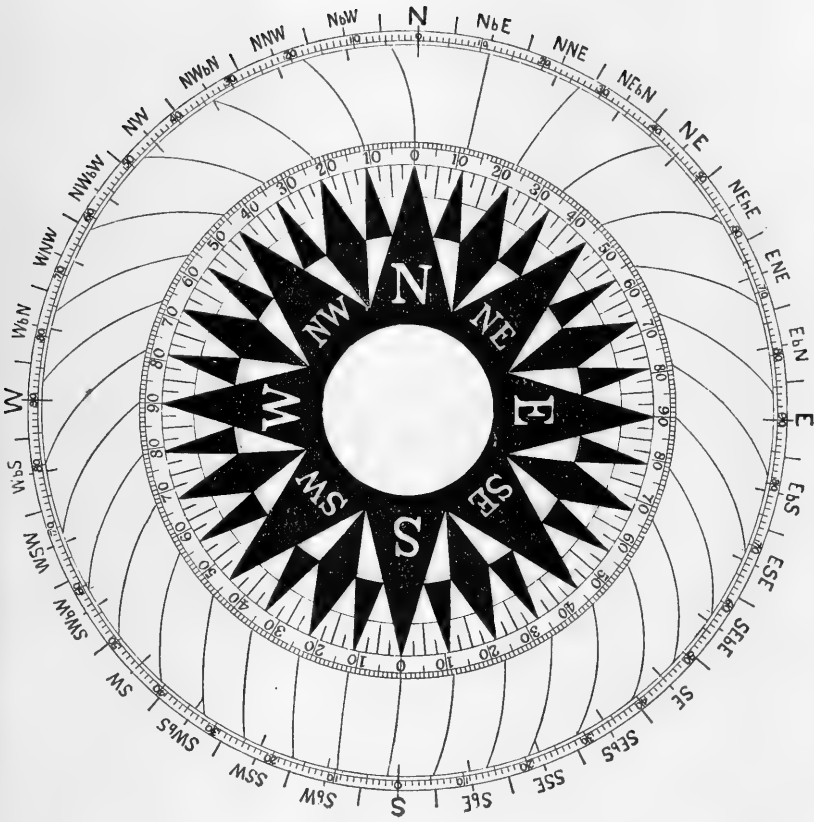
|| To 2,276 turns.

† To 1,530 turns.

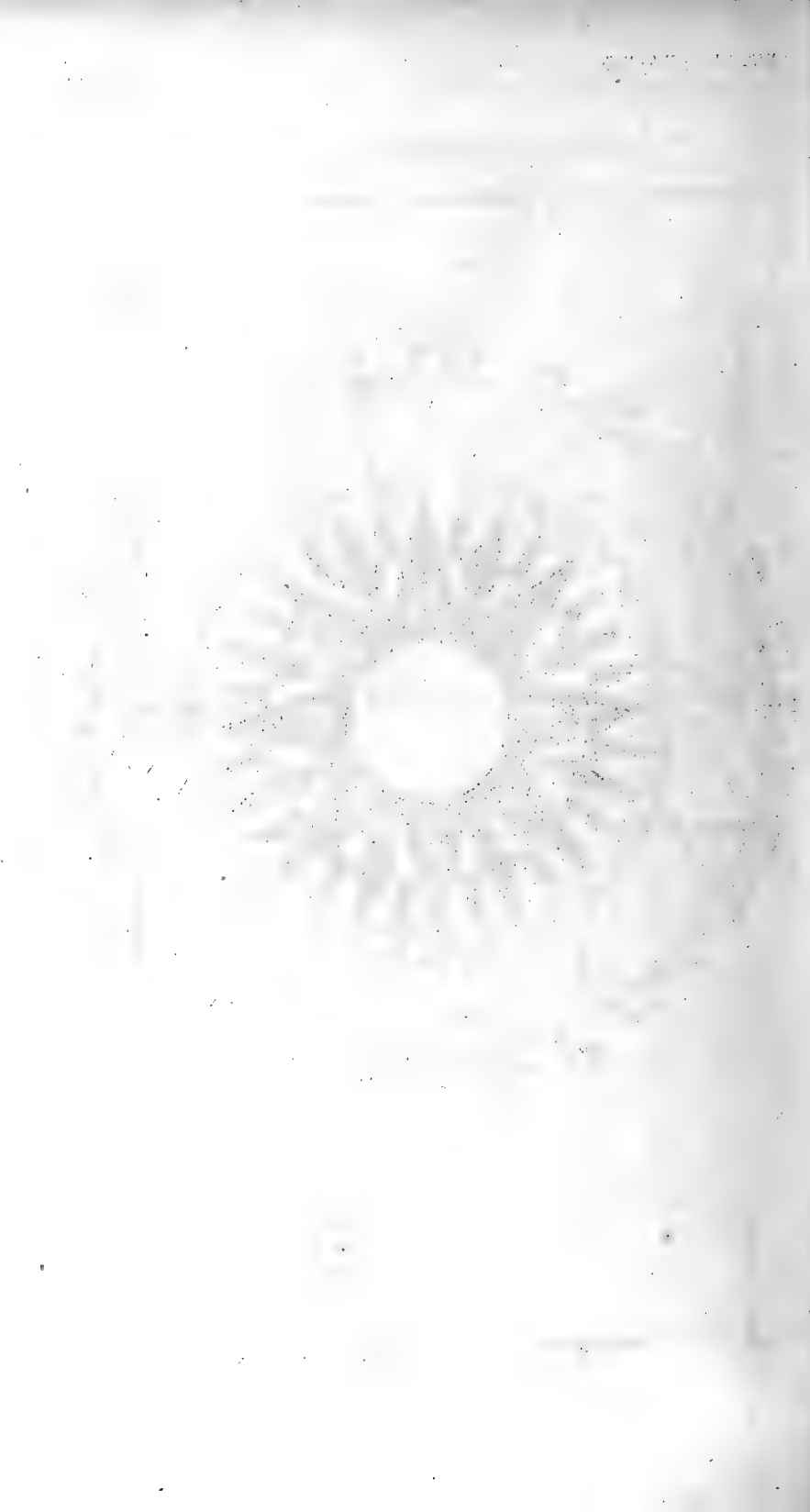
§ To 2,125 turns.

SOUNDING—COMING UP.

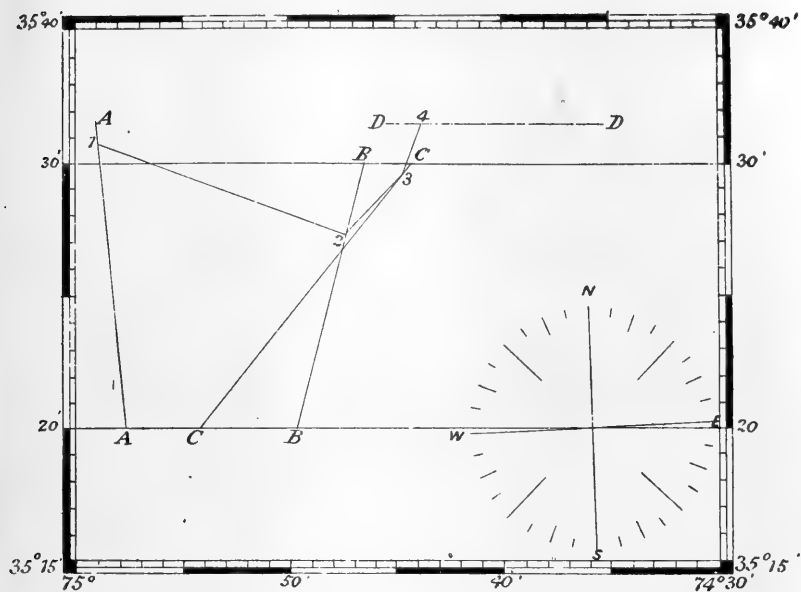
100 to surface.....	0 00	1 00	1 05	1 25	1 00
200 to 100.....	1 27	1 00	1 30	1 25	0 57
300 to 200.....	0 37	1 00	1 30	1 25	0 58
400 to 300.....	0 37	1 00	1 30	1 25	1 00
500 to 400.....	0 35	1 00	1 30	1 25	1 00
600 to 500.....	0 50	1 00	1 30	1 25	1 00
700 to 600.....	0 38	1 00	1 30	1 20	1 00
800 to 700.....	0 32	0 57	1 30	1 20	1 05
900 to 800.....	0 40	0 50	1 30	1 25	1 07
1,000 to 900.....	0 47	0 51	1 30	1 30	1 05
1,100 to 1,000.....	0 46	0 52	1 45	1 25	1 10
1,200 to 1,100.....	0 45	1 05	1 45	1 25	1 15
1,300 to 1,200.....	0 47	1 05	1 45	1 25	1 14
1,400 to 1,300.....	0 51	1 05	1 45	1 25	1 13
1,500 to 1,400.....	0 52	1 10	2 00	1 30	1 00
1,600 to 1,500.....	0 57	1 15	1 05	1 00	.....
1,700 to 1,600.....	0 55	1 10	1 40	.....	.....
1,800 to 1,700.....	1 00	1 27	1 30	.....	.....
1,900 to 1,800.....	1 20	1 30	1 30	.....	.....
2,000 to 1,900.....	0 40	1 33	1 30	.....	.....
2,100 to 2,000.....	.....	2 15	1 30	.....	.....
2,200 to 2,100.....	.....	2 25	0 30	.....	.....
2,300 to 2,200.....	.....	2 00	.....	.....	.....
Total time.....	12 36	28 30	32 50	21 15	16 04
Average speed per 100 fathoms.....	0 36	1 12	1 28	1 19	1 02



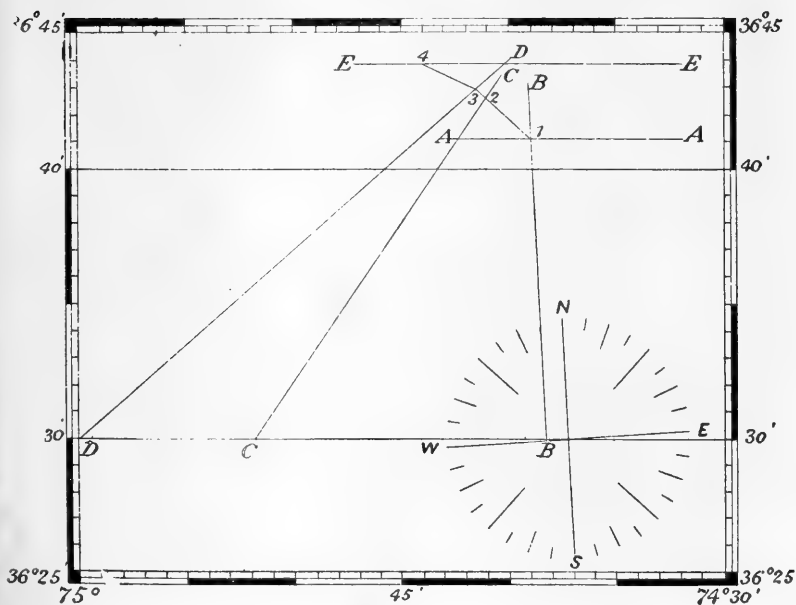
Steering card, Chesapeake Bay, April, 1883.

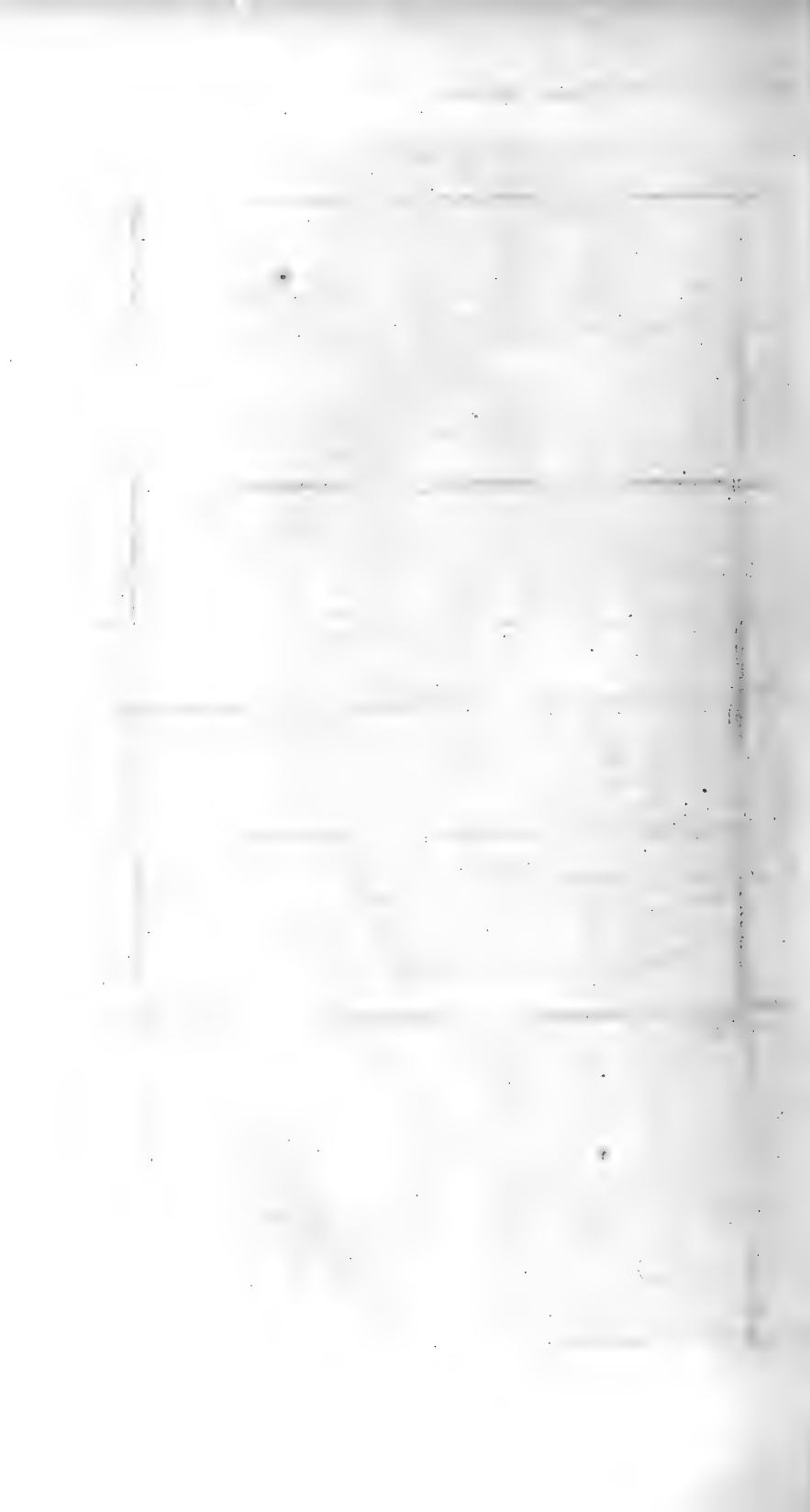


CASE I.

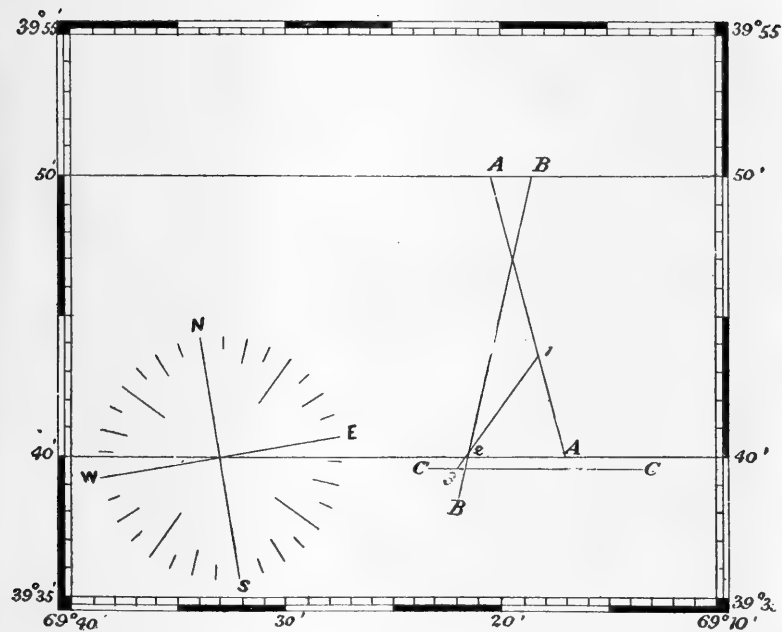


CASE II.

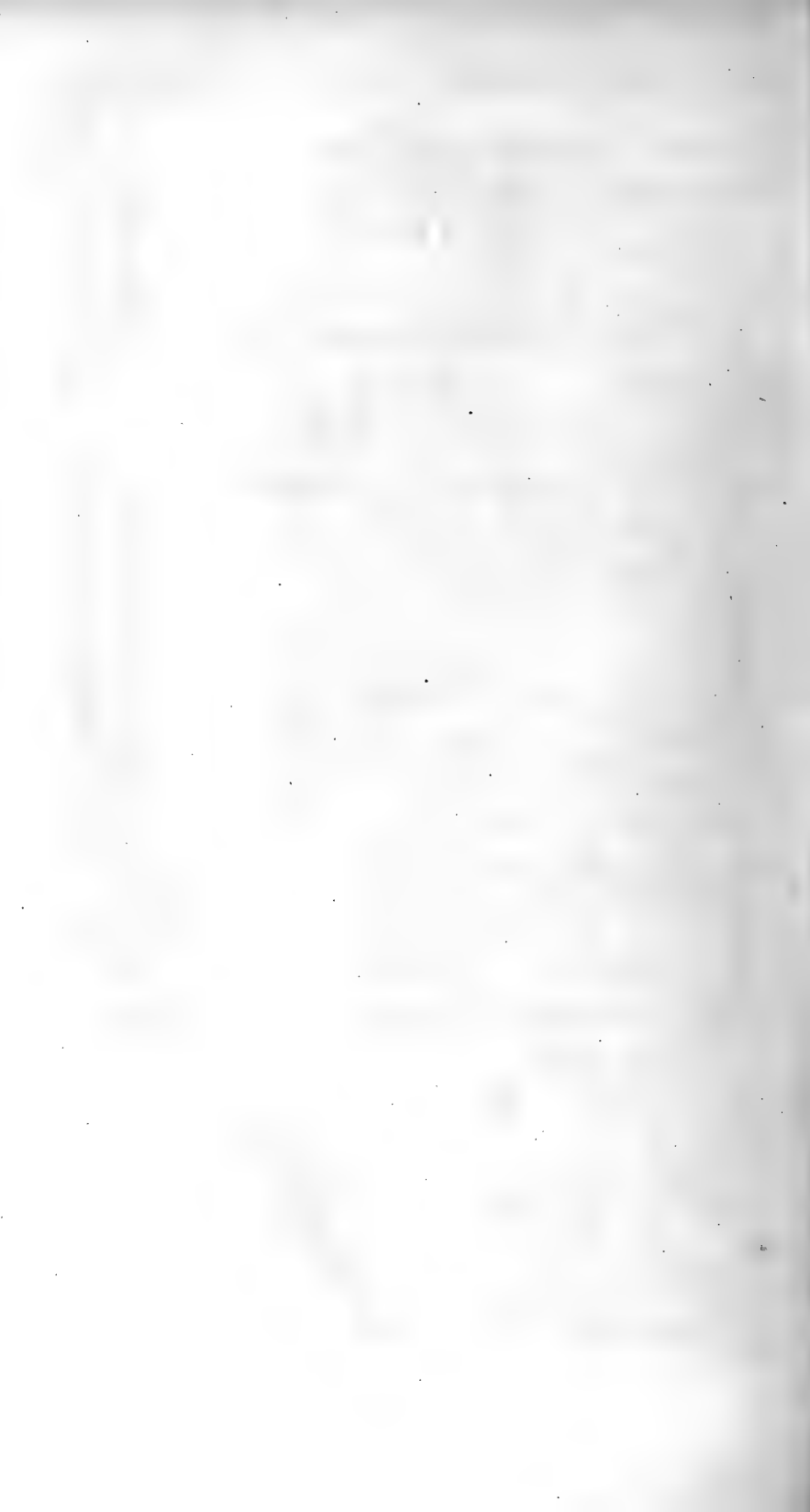




CASE III.



Illustrative case in navigation.



INDEX.

[NOTE.—The references are to page-figures in brackets.]

	Page.
Ada E. Terry, schooner.....	51
Agonidae	63, 75
Albatross	1, 59, 88
cruises of	61, 96
equipment of	59
Alepocephalidae	64, 78
Alepocephalus agassizii.....	64, 76
productus	64, 78
Alewives, taking of	18
Alice, schooner	51
Almy, Jacob	10, 31, 32, 35, 40, 44
Amphipods	10
Analysis of water	89
Anguilla conger	84
Anguillidae	65, 84
Annie, schooner	17
Anthozoa	61
Apparatus, deep-sea, testing of	2
Argyropelecus hemigymnus	64, 80
Aspidophoroides monopterygius	63, 75
Atlantic and Virginia Fertilizing Company	23
Back River menhaden factory	18
Bailey, W. G	27
Baird, G. W	1, 102
Spencer F.....	4, 10, 48, 89
Baird's distiller	89
Bait.....	58
for codfish	36
Baker, A. C	102
Ball, Nicholas	33
Baltimore, Md., docking of vessel at	101
Bar and tangles	104
Barnacles	102
Bassozetes normalis	62, 70
Bathymyzon bairdii	65, 85
Bathysaurus agassizii	64, 78
Beam trawl	103, 104, 105
Beatley, L. J	14
Beckwith, F. H.....	20
Behren's apparatus	89
Bellows, Rasquith, Squires & Co	17
Benedict, James E	59
Berth deck	92
Berycidae	64, 77
Bishop, O. H.....	24
Blackfish, appearance of	5
Blennius chuss	70
regius	71
Bliss & Creighton chronometer	96, 98
Bliss's patent log	96
Block Island fisheries.....	33, 36

	Page.
Bluefish, abundance of	22, 25
bait for	21
habitat of	22, 34
taking of 14, 15, 16, 17, 18, 21, 23, 25,	27, 28, 35
time of appearance of	34
Boilers, work on	3
Bosman, R. T.	13
Boston Fish Bureau	52
Boush, C. J.	102
Bowditch's Navigator	98, 100
Branford, Conn., fish factory at	26
Brosmius brosme	63, 73
flavescens	73
vulgaris	73
Brotulidæ	62, 70
Brown & Brightman	32
Brown & Co., S. S.	20
Brown & Lennon	10
Bulkheads	88
Bureau of Medicine and Surgery	89
Navigation	97, 98
Burgess, G. T.	13
Burns, John W.	26
Butterfish, taking of	21, 25
Cabin	88
Calliopus læviusculus	60
Cancer	60
Carangidæ	63, 77
Caranx chrysus	77
hippos	77
pisquetus	63, 77
Caulolepis longidens	64, 78
Cayenne as food of mackerel	37
Centridernichthys uncinatus	76
Chænopsetta ocellaris	67
Chalinura simula	62, 69
Chandler, W. E.	101
Chart-room	98
Chauliodontidæ	65, 83
Chauliodus sloani	65, 83
Chemical apparatus	89
Cherry Point, menhaden factory at	18
Chesapeake Bay menhaden factories	18
Chimæra abbreviata	65, 85
Chimæridæ	65, 85
Chiridotea tuftsii	60
Chronometers	96, 98
errors of	99
Citharichthys arcifrons	62, 66
Coast and Geodetic Survey	10

	Page.		Page.
Coast chart, perfection of	7	Dixon Oil and Guano Company's works....	25
Codfish, bait for	36	Dogfish, abundance of	54
food of	31, 33, 55	taking of	9, 45, 54, 55, 57
habitat of	35, 36	Dolphin, taking of	57
menhaden in stomachs of	31, 33	Doran, S. H.	23
migration of	33	Downs, W.	21
scarcity of	36	Draught	88
schooling of	35	Dredge	104
size of	35	rope, loss of	7, 38
spawning of	33, 35	tangles	103
taking of	35, 36, 45, 54	Dredging-engine	90
time of appearance of	33	Dredging and trawling record	103, 104
value of	36	Dynamo engine	98
Cold-room	90	Echinoderms	61
dimensions of	91	Edison Company	3
use of	91	Electric-light apparatus	3
Collins, J. W.	44, 48, 58, 59	use of	9, 28, 29, 39, 42, 56, 60, 61
Commissioned officers	102	lighting	94
Compass, testing of	4	plant	2
Conger occidentalis	84	Ellen M. Adams, schooner	51
oceanicus	65, 84	Enchelyopus regalis	71
vulgaris	84	Engine-room	88, 93
Copeland, C. W.	1	Engines	88
Copepods	60	working of	1
Coral, specimens procured	39	Equipment of laboratory	90
Corwin & Cartwright	23	Errors of the chronometer	99
Coryphæna globiceps	77	Eurypharyngidæ	65, 85
sueuri	63, 77	Excelsior Oil Works	24
Coryphænidæ	63, 77	Explorations, deep-sea	3, 5, 9, 28, 29, 30, 38, 20, 41, 42, 43, 46, 47, 48, 95
Coryphænoides carapinus	62, 69	Falcon Oil Works	25
rupestris	62, 69	Fares, apportionment of	35, 36
Cottidæ	63, 75	Fire-room	93
Cottunculus microps	63, 76	Fish Hawk	11
Cottus acadian	75	Fish, scarcity of	41
æneus	63, 75	Fish-traps, decrease of fish taken in	18
mitchilli	75	Fishes, economic value of	36
monopterygius	75	taken, list of	62
uncinatus	76	Fishing-ground, location of	21
Crabs in stomachs of codfish	55	Flounders in stomachs of codfish	55
taking of	47, 57	taking of	28
Crangon vulgaris	60	Floyd, David G.	25
Crevallé, taking of	57	Food-fishes, abundance of	22
Crowder, J. H.	15	scarcity of	23, 32
Cruising of Albatross	96	Food of codfish	31, 33, 55
Crustacea	61	of mackerel	37
Cunner, taking of	8, 55	of menhaden	27, 32
Cusk, habitat of	36	of shark	47, 57
taking of	36	Foraminifera, procuring of	9, 42
Cyclothone lusca	64, 80	Gadidæ	63, 70
Dager, schooner	14	Gadus auratus	72
Decapods	60	brosme	73
Deck-house	88	callarias	72
Deep-sea apparatus, testing of	2	carbonarius	73
explorations	3, 5, 9, 28, 29, 30, 38, 39, 41, 42, 43, 46, 47, 48, 95	cimbricus	72
trawl	103, 104	macrocephalus	72
Delaware Breakwater, menhaden factories at	19	morrhua	63, 72
Density of sea water	108, 109, 110	ogæ	72
De Voe & Co.	102	ogak	72
Diastylis sculptus	60	tenuis	70
Diehl, S. W. B.	4, 97	virens	73
Dinghy, use of	8	Gale, Albatross in	45
Displacement	88	Galeorhinidæ	65, 87
Dixon, Hiram R.	25	Gastrostomus bairdii	65, 86
		General Carmichel, schooner	14

	Page.		Page.
George Alvin	15	Leptocephalidæ	65, 84
Georgeanna, smack	33	Leptocephalus	65, 84
Gill, Theodore	62	Lighting	88, 94
Glyptocephalus cynoglossus	62, 67	of berth deck	92
Goosefish, taking of	45, 55	Linen, James	20
Grampus, appearance of	36	Lizzie Bell, schooner	13
Grapnel dredge	104	Lobsters, abundance of	55
Great Skua gull	51	habitat of	55
Greenfish, taking of	14	in stomachs of codfish	55
G. S. Allen, steamer	19	taking of	45, 55
Gulf Stream	5, 38, 40, 43, 60, 100	Log	96
Gulls, appearance of	58	Lophiida	62, 66
Haddock, habitat of	36	Lophilatilus	62
taking of	36	Lophius americanus	66
Hagdots, abundance of	51	piscatorius	62, 66
Hake, taking of	9, 41, 45, 54, 55	Louisa A. Muir, schooner	14
Halibut, habitat of	36	Louise, smack	32
taking of	36	Luce Brothers	11, 19, 20, 28
Halientæa senticosa	62, 66	Lycodes verrillii	63, 73
Haloporphyrus viola	63, 71	Lycodidæ	63, 73
Halosauridæ	64, 79	Lycodonus mirabilis	63, 74
Halosaurus goodei	64, 79	Lydia Ryder, schooner	36
macrochir	64, 79	Lyons, T. A.	96
Harriet Howarth, schooner	15	McAvoy, S. M.	102
Hawkins Brothers	24	Mackerel, abundance of	27, 37
Hawkins, John	102	appearance of	6, 31, 34, 40, 44, 45, 54
Haynie, N. A.	14	as bait for codfish	36
Hazen, W. B.	53	food of	37
Heating	88, 93	habitat of	19, 20, 27, 36, 37
Hemitripteris acadianus	75	migration of	37, 50, 51
americanus	63, 75	schooling of	36
Herndon, C. G.	88, 102, 108	size of	37
Herring as bait for codfish	36	taking of	20, 21, 22, 26, 27, 28, 36, 37, 52
taking of	36	time of appearance of	20, 21, 23, 27, 32, 33, 36, 37, 38
Heteromysis formosa	60	McNamara, A. R.	16
Hickory shad, taking of	18	Macruridæ	62, 68
Hilgard's salinometer	90	Macrurus	81
Histiobranchus infernalis	64, 82	asper	62, 69
Homarus americanus	60	bairdii	62, 68
Horizontal needle	4, 97	carminatus	62, 68
Hydrographic Office	101	Magnetic observations	4
survey	99	Magnetic survey	10, 97
Hyperchoristus tanneri	64, 79	Malthidæ	62, 66
Ice-house	90	Mansfield, Charles D.	101, 102
dimensions of	91	Marsh, Booth & Co.	14
Icelus uncinatus	63, 76	Martin, S. J.	53
Idotea irrorata	60	Mary E., sloop	21
Irvin & Co., L. H.	18	Mary Woods, schooner	11, 22
Jaegers, occurrence of	51	May, S. H.	102
James & Co.	16, 17	M. B. Tower, schooner	6
Jennings, W. M.	23	Medical instruments	89
J. W. Luce, sloop	18	Melanostigma gelatinosum	63, 74
Kelsey, E. R.	26	Menhaden, abundance of	18, 19, 21, 22, 24, 25, 28
Ketchum, C. E.	16	annual catch of	21, 22, 23, 24, 25, 26, 28, 32
George	13	appearance of	11, 31, 33
Kidder, J. H.	102	as bait	21, 50, 57, 58
King, H. R.	102	comparative catch of	13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 27, 32
Kingfish, taking of	23	economic value of	16, 18, 21, 22, 23, 24, 25, 28
Kitchen	89	factories, capacity of	18, 19, 21, 22, 23, 24, 25, 26, 28, 32
Labichthys carinatus	64, 82		
elongatus	64, 83		
Laboratory	89		
Lawrence, John L.	25		
Length	88		

	Page.		Page.
Menhaden factories, location of	11, 18, 19, 21, 22, 23, 24, 25, 26, 32	Onos rufus	63, 72
food of	27, 32	Osborn & Sons	22
habitat of	12, 13, 14, 15, 16 19, 20, 21, 22, 23, 26, 27, 32, 33	Ostrich, schooner	16
increase in number of	17	Oyster, habitat of	34
in stomachs of codfish	31, 33	Palaemonetes vulgaris	60
migration of	15, 16, 17, 19, 20, 21, 22, 24, 25, 26, 32, 33, 34	Pantry	93
schooling of	23, 24, 26, 27, 32, 33	Paralichthys dentatus	62, 67
size of	15, 17, 19, 20, 21, 22, 23, 26, 27, 32	oblongus	62, 68
spawning of	12, 16, 24, 27, 32, 33	Parasites	55, 61
stranding of	18	Paratractus pisquetos	77
taking of	11, 12, 13, 14, 15, 16, 19, 20, 21, 33	Parkinson & Frodsham chronometer	96, 98
time of appearance of	13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 32	Peconic Oil Works	23
Merlangus purpureus	73	Perca marinus	76
Merluccius bilinearis	63, 72	norvegica	76
Meteorological record	111, 112	Peristedium miniatum	63, 75
M. E. Torrey, schooner	6	Peters, E. M.	36
Micrometer telescope	96, 98	Petrels, abundance of	39
Miles, George W.	26	Petromyzon americanus	85
Milford, Conn.	26	bairdii	65, 85
Miller, G. A.	102	marinus	65, 85
N. B.	102	Petromyzontidæ	65, 85
Miner, R. H.	62, 102	Petty officers	102
Mollusca	61	Photographer	90
Monolene sessilicauda	62, 66	Phycis chesteri	63, 66, 71
Montauk Oil Company	25	chuss	63, 66, 70
steamer	26	punctatus	71
Morran, M. J.	27	regalis	71
Morrhua americana	72	regius	63, 71
Mother Carey's chickens	61	tenuis	63, 70
appearance of	8	Piankatank River menhaden factories	18
Mud-bag	59	Pierce, D. T.	37
Muraena nigra	84	Pilot-house	88
pinnata	81	Platessa oblonga	67
Mysis americanus	60	ocellaris	67
Myxine glutinosa	65, 85	plana	67
Myxinidæ	65, 85	quadrocellata	68
Myzont	62	Plectromus suborbitalis	64, 77
Nannie E. Waterman, schooner	37	Pleuronectes americanus	62, 67
Napier diagram	97	cynoglossus	67
National Museum	61	melanogaster	67
Naval hospitals	95	oblongus	68
Navy Department	96, 97, 98	Pleuronectidæ	62, 66
Neamoug Oil Works	24	Pleuronectus dentatus	67
Needles, horizontal	4, 97	oblongus	67
vertical	4, 97	Pogies, taking of	18
Negretti-Zambra deep-sea thermometer	29	Pollachius carbonarius	63, 73
thermometers, loss of	28	Pollock, habitat of	36
Negus chronometer	96, 98	Porpoises, abundance of	37
Nemichthyidæ	64, 82	appearance of	5, 11, 31, 33, 35, 36, 40, 48, 55
Nemichthys scolopaceus	64, 82	taking of	61
Nereis megalops	60	time of appearance of	18
New York, N. Y., docking of vessel at	10	Portland, steamer	27
Norfolk Naval Hospital	95	Potomac River	97
Notacanthidæ	64, 83	Preston & Raynor	24
Notacanthus analis	64, 83	Price, Thomas T.	25
phasganorus	64, 83	Prionotus carolinus	63, 74
Novelty Oil Works	24	palmipes	74
Officers	102	pilatus	74
Ommastrephes illecebrosus	60	punctatus	63, 74
Onos cimbrius	63, 72	Prowess, schooner	16
		Pseudorhombus dentatus	67
		oblongus	67
		ocellaris	67
		Ptilochirus pinguis	60

	Page.
Puffing pigs, abundance of	33
Puffinus major, abundance of	51
Pusey & Jones Company	1, 2, 88
Pusey, C. W.	1
Quickstep, steamer	20
Rachet, D.	33
Raia eglanteria	65, 86
lævis	65, 86
ocellata	65, 86
radiata	65, 86
Raidæ	65, 86
Rake dredge	103, 104
Ranger Oil Company	25
Read, George H.	101
Record of speed of trawling and sounding	113, 114
Reed & Son, E. W.	14, 15
Repairs	40, 42
Rhombus cryptosus	77
Richard K. Fox, schooner	6
Richie liquid compass	96
Roberts's compound	102
Rogers's micrometer telescope	96, 98
Rope, loss of	31
Safford, W. S.	44
Salmo mülleri	81
Salmon, taking of	23
Salpa, appearance of	8
Samuel S. Brown, steamer	20
Saunders, W. F.	19
Schroeder, Seaton	96, 102
Scientific instruments	89
library	89
Scoliodon terræ-novæ	65, 87
Scopelidæ	64, 81
Scopelus glacialis	81
mülleri	64, 81
Scorpena americana	75
dactyloptera	76
Scorpenidæ	63, 76
Screw propellers	88
Scup, habitat of	34
taking of	25
Scylliidæ	65, 87
Scyllium retiferum	65, 87
Sea bass, taking of	23, 32, 45, 55
Sea water, specific gravity of	108
temperature and density of	108, 109, 110
Sebastes marinus	63, 76
norvegicus	76
Sebastoplus dactylopterus	63, 76
Seine, dimensions of	13, 14, 19, 20, 21, 23, 26, 27, 32
durability of	13, 14, 15,
16, 17, 18, 19, 20, 21, 23, 32	
length of	13, 14, 15,
16, 17, 18, 19, 20, 21, 23, 26, 27, 32	
Selachian	62
Serial temperatures, method of taking	29
table of	106
taking of	30, 38, 42, 48
Serrivomer beanii	64, 182
Shad, taking of	18, 20, 21
Sharks, abundance of	19, 20
food of	47, 57
taking of	47, 57, 61
Sheepshead, taking of	18

	Page.
Sigmops stigmaticus	65, 84
Sigsbee's deep-sea sounding machine	5
Sigsbee water-cup	29, 42, 90
Simenchelys parasiticus	65, 84
Skate, taking of	9, 41, 45, 55
Skinner & Sons' Marine Railway, William	101
Smith, James.	24
Sandersor	44
S. I.	60
Yarrington & Co.	23
Sommers, Edward	17
Sounding wire, loss of	28
Spanish mackerel, taking of	13, 17, 18
Specific gravities, taking of	42, 46
Specific gravity of sea water	90, 108
Specimen cup, loss of	30
Specimens of coral procured	39
procuring of	7, 30, 42,
46, 48, 66, 67, 68, 69, 70	
Speed	88
Spicer, William	19
Spikes	56
Spinacidæ	65, 86
Spinivomer goodei	64, 82
Squalus acanthias	65, 86
Squid, abundance of	41
appearance of	29, 56
as bait for codfish	36
attracted by electric light	29
in stomach of shark	47, 57
taking of	36, 56
Squires, George P.	17
Stalley, F. L.	102
Star-fish, taking of	9, 47, 57
Starry Flag, schooner	6
State-rooms	89, 93
Steam-heaters	93
Steerage	93
Stephanoberyx monæ	64, 77
Stephen Hopkins, schooner	15
Sternoptychidæ	64, 80
Sternoptyx diaphana	64, 80
hemigymnus	80
mediterranea	80
Sthenotuthis bartramii	60
Stomias ferox	64, 79
Stomiidæ	64, 79
Stomodon bilinearis	72
Store-rooms	93
Stromateidæ	63, 77
Stromateus triacanthus	63, 77
Sturtevant exhaust fan	93
Sword-fish, appearance of	28, 31, 33, 34, 35, 40
Synaphobranchidæ	64, 81
Synaptobranchus	65, 84
pinnatus	64, 81
Synodontidæ	64, 78
Tailor, salt-water, abundance of	22, 25
bait of	21
habitat of	34
taking of	14, 15, 16, 17,
18, 19, 20, 23, 25, 27, 35	
time of appearance of	34
Tanner sounding machine	29
Z. L.	1, 58, 102, 103, 104, 106, 113

	Page.		Page.
Tason, A	14	Ventilation of berth deck	92
Tautog, taking of	28	Vertical needle	4, 97
Temperature of sea water.....28, 38, 46, 108, 109, 110		Wainwright, Richard	4, 97
water, effect of	12	Walker's patent log	96
Thalassidroma leachii	61	Ward-room	93
wilsoni	61	Washington Naval Hospital	95
Thermometer, loss of	30	Water, analysis of	89
Thomas Bell, schooner	17	examination of	9
Thompson, Noah	49	specific gravity of	90
Tile-fish grounds, examination of	40	specimens, method of taking	29
Till, G. B	102	preservation of	9
Timbs, N. H	15	procuring of ....28, 29, 30, 38, 48	
Tonnage	88	Weakfish, abundance of	22
Trawl, loss of	7, 30	habitat of	34
net, loss of	30	taking of	18, 20, 21, 23, 25, 28
Trawling and sounding, record of speed of. 113, 114		Wells, Henry	24
Trigla carolina	74	Whales, appearance of	35, 40
palmipes	74	habitat of	18
punctata	74	Whiting, taking of	41
Triglidæ	63, 74	William A. Wells, steamer	27
Turtles, appearance of	58	Wilmington, Del., Albatross built at	1, 88
Tuthill & Co., George E	24, 25	Wise steam motor	99
Tuttle, Capt. A. H	32	Wise, Thomas	99
T. W. L. Geser, schooner	36	Wood's Holl, Mass. ....29, 34, 40, 42, 44, 60, 89, 95, 96	
United States Naval Hospital	47	Wreck sighted	39, 40
Urothea	60	Wright, Charles	102
Vail, D. F	21, 22	Xiphias gladius	65, 83
Value of Block Island fisheries	33	Xiphiidæ	65, 83
Ventilation	88, 93	Yarington, Charles	22

III.—EXPLORATIONS ON THE COLUMBIA RIVER FROM THE HEAD OF CLARKE'S FORK TO THE PACIFIC OCEAN, MADE IN THE SUMMER OF 1883, WITH REFERENCE TO THE SELECTION OF A SUITABLE PLACE FOR ESTABLISHING A SALMON-BREEDING STATION.

By LIVINGSTON STONE.

In the Territory of Montana, on the great Continental divide which separates the Atlantic slope of North America from the Pacific slope, and near where it is intersected by the forty-sixth parallel of latitude, is a very interesting spot. Here two tiny rivulets, close to each other at their source, set out on a long and widely diverging journey; one, flowing southward and taking a strangely circuitous course, becomes the Missouri River, and finally empties its waters into the Atlantic through the broad delta of the Mississippi, 4,000 miles from where it started; and the other, flowing northward, becomes at last the Columbia River, and enters the Pacific Ocean through an outlet 15 miles wide and fully 1,200 miles from its source. The latter rivulet, which is the one with which this report is concerned, although it is, correctly speaking, Clarke's Fork of the Columbia River, is not generally known by that name until it has become the river which is formed by the junction of the Flathead and Missoula. Looking now for the various sources which have formed this comparatively large river, we find that they all head in that part of the Bitter Root Mountains and the main range of the Rockies which, roughly speaking, lie between the forty-fifth and forty-eighth parallels of latitude and receive the waters of all the numerous small streams which flow from the southwest slope of the Rocky Mountain range and the northwest slope of the Bitter Root range. Most of the streams rising in the Bitter Root Mountains flow into the Bitter Root River, while the streams rising in the Rocky Mountain range flow into the Big Blackfoot River and the Hellgate River, which latter stream is known a few miles above, and from there to where it heads in the mountains, as the Deer Lodge River. Just above Missoula, Mont., the Big Blackfoot River and the Hellgate River unite and flow together to Missoula, where they receive the waters of the Bitter Root River from the south. Below the junction of these streams, at Missoula, the river is known as the Missoula River, until it receives the waters of the Flathead River from the north, at the southeastern end of the Cœur d'Alène range of mountains, below which junction it

is called the Clarke's Fork of the Columbia, although the whole course of the river known under the various names of Deer Lodge River, Hellgate River, and Missoula River might be properly considered as Clarke's Fork of the Columbia, these being the original Clarke's Fork and forming one continuous stream as much as the Mississippi does from the Falls of Saint Anthony to Saint Louis. From the junction of the Flathead and Missoula the river flows for about 75 miles to Pend d'Oreille Lake through a magnificent wooded cañon which presents some of the finest scenery on the continent.

Pend d'Oreille Lake is really formed by the widening of the river, and is a large, beautiful sheet of water surrounded by picturesque mountains and navigable over its entire area. At the outlet of Lake Pend d'Oreille the river comes together again, taking here still another appellation, viz., Pend d'Oreille River, and flows smoothly and slowly for a distance variously estimated at from 15 to 30 miles, where it flows over a vertical fall 8 or 10 feet* in height and enters a mountainous cañon through which it rushes with such violence as to be wholly unnavigable, and, finally leaping over a fall of 15 feet in perpendicular height, it empties into the Columbia just north of the United States boundary, in about latitude 49° and longitude 117½°.

The Northern Pacific Railroad crosses the great Continental divide of the Rocky Mountain range just where the little streams and mountain torrents gather together to form the Deer Lodge River, which, as above stated, is the upper portion of Clarke's Fork under another name. After crossing the divide the railroad follows along down the valleys of the Deer Lodge, Hellgate, Missoula, and Clarke's Fork, and passing around the north side of the main body of Lake Pend d'Oreille, crosses the western arm of the lake, which finally narrows again into the river. Here the road permanently leaves the valley of Clarke's Fork nearly at right angles, and does not strike the Columbia River again till it reaches the mouth of Snake River, at Ainsworth, 336 miles from the ocean.

My instructions being to select a point for collecting salmon eggs which would be near the line of the Pacific Railroad, this precaution being necessary both for convenience in operating the station and for facility in distributing the eggs, it follows that any point above Pend d'Oreille Lake would be a perfectly satisfactory place for a collecting and distributing station, provided that a sufficient number of spawning salmon could be secured. This last most essential condition is wanting, however, along this whole line of river channel, for very few, if any, salmon ever reach Pend d'Oreille or the waters above it. This fact was a great surprise to the writer, but it is undeniable.

The testimony of all the persons consulted on the subject at Deer Lodge, Missoula, Sand Point, and at various smaller stations on the railroad was unanimous to the effect that no salmon were ever caught in Clarke's Fork or above. One man who was interrogated said that

* Dr. Suckley, in 1853, estimated the height of this fall at 6½ feet.

he had caught salmon in Lake Pend d'Oreille, but finally admitted that he had caught but one salmon, and the admission was made in such a way as to make the catching of the one salmon appear doubtful. At all events it is certain that no point on or above Lake Pend d'Oreille would furnish salmon enough for obtaining any considerable number of eggs.

The cause of the absence of salmon from a lake which flows directly into one of the greatest salmon rivers of the world is supposed by the local inhabitants to be the falls, mentioned above, which occur on the river about 15 miles below the outlet of the lake commonly known as the Falls of Seniakwoteen. I will add here that these falls are not properly called Seniakwoteen Falls, for the word means "a crossing," and, although there is a crossing a few miles below the mouth of the lake, the falls are much farther and are neither near nor in any way connected with the crossing or "Seniakwoteen" proper. The residents on the lake think that these falls prevent the salmon from coming up the river, but the writer thinks that it is quite as likely that the salmon are all or nearly all stopped by the falls at the mouth of the Pend d'Oreille River (Clarke's Fork) where it empties into the Columbia. A white ("squaw man") fur-trader lives at the crossing (Seniakwoteen), but I am informed that there is not another white settler along the whole course of the river from this point to its mouth. It is consequently very difficult to get any information concerning the run of salmon in the river, but the few persons that know anything about that region, who were consulted, could not remember having seen or heard of any salmon there, and the probability appears to be that very few, if any, salmon get past the falls at the mouth of Clarke's Fork and the intervening cascades between there and the falls below Lake Pend d'Oreille.

However this may be, the falls of Seniakwoteen (so-called) would not be a suitable place for a salmon-hatchery station, for three reasons:

1. It is too far from the railroad, being 30 or 40 miles by the nearest trail to a railroad station.

2. The region through which the railroad passes was one of the wildest portions of the United States till the railroad was built through it, and is now only very sparsely settled and very poorly furnished with supplies. The expense and inconvenience of building and carrying on a salmon-hatching station anywhere in this region would consequently be very great; so great, indeed, as to render the undertaking virtually impracticable.

3. The Indians on the Pend d'Oreille River, or, more properly speaking, the Pend d'Oreille "division" of Clarke's Fork, have always held undisputed possession of their wild and rugged cañon, and are extremely jealous of the intrusion of white men.

I am informed that they have driven out all white men who have come in there to settle, a *prima facie* evidence of which is found in the fact that there are no white settlers there at this day except the fur-trader just mentioned. I need not say that this would be a serious objection

to the establishment of a station there, as no one could tell what these high-spirited northern Indians might do at any moment in a remote and uninhabited place like the cañon of the Pend d'Oreille, provided they resented the advent of white men, as they undoubtedly would. I wish to say, by way of explanation, that I do not consider the country in question unsafe for white men to travel through, nor is there any likelihood of an outbreak by the native inhabitants along the river. I do not mean that either of these things is probable. What I mean to say is that, if a small body of white men should go into the cañon to stay and their presence should be objectionable to the savage residents of the country, they would probably find some means of getting rid of the obnoxious intruders.

Below the falls, near Seniakwoteen, to the mouth of Clarke's Fork, and from there on the Columbia to the mouth of Snake River, any place, however favorable on other accounts, would be out of the question as a collecting and distributing point for salmon eggs, on account of its distance from the railroad and its general inaccessibility. I will add that there is scarcely a white man to be found in that whole region of nearly 10,000 square miles, embraced between the Pend d'Oreille River on the north and east, the Columbia on the west, and the forty-eighth parallel on the south, except the very few settlers directly on the Columbia and Colville Rivers.

It might be thought that if a station was established on the Columbia, supplies could be brought up the river by steamer. This, however, could not be depended on at present, because from Priest Rapids to Grand Rapids, inclusive, the river is unnavigable at the following places, viz.: At Priest Rapids, 409 miles from the mouth of the Columbia; at Cabinet Rapids and Rock Island Rapids, 463 miles; at Foster Creek Rapids, Whirlpool Rapids, and Mahkin Rapids, 559 to 582 miles; at Spokane Rapids, 646 miles; and at Grand Rapids, 704 miles.

But as navigation could be opened through these rapids at a reasonable expense, and as this will probably be done sometime, because it would open up a navigable river distance of 302 miles to Kettle Falls, the time may come when it will be found desirable to establish a hatching station somewhere on the Columbia River between the mouth of Snake River and Kettle Falls, which latter place itself seems to present many conditions favorable to such an undertaking.

It was remarked above that the Northern Pacific Railroad leaves the valley of Clarke's Fork quite abruptly just below Lake Pend d'Oreille. From here it pursues a general southwesterly course, crossing the great plain of the Columbia and not reaching the river again till it gets to Ainsworth, a railroad station on the Columbia at the mouth of the Snake River. On its way, however, it crosses an important river. This river is the Spokane, a stream flowing out of Cœur d'Alêne Lake and emptying into the Columbia 309 miles above the mouth of Snake River and 645 miles from the ocean. The Spokane has always been

famous as a great salmon river. Dr. Suckley often mentions it in that connection, and ever since the country has been opened up by white men it has been known that the Indians from all quarters assemble in the fall on this river and at the mouth of the Little Spokane, 8 miles to the northwest, to get their winter's stock of salmon. When I arrived at Spokane Falls, which is the point at which the railroad touches the Spokane River, and which is 70 miles from its mouth, I heard that Indians were fishing for salmon at the mouth of the Little Spokane, 8 miles distant. On driving over to the Little Spokane we found a large camp of Indians there, several of whom were industriously engaged in putting a salmon trap across the river. These traps consist of a dam of poles firmly bound together by withes and extending entirely across the river, with holes or traps at intervals into which the salmon can enter, but from which they cannot return. Having brought an interpreter with us we soon learned from the Indians that great numbers of spawning salmon came up to the mouth of the Little Spokane about the 1st of September. It was impossible to learn from the Indians how many salmon could be caught there in the spawning season, owing, I presume, to a trait which I have often observed among Indians, viz., an inability to fix with any precision upon exact numbers. For instance, when the interpreter asked the Indian he was talking with if twenty-five was the number that they caught in a day, the Indian answered yes; and when he asked him if they caught a hundred a day, he also said yes; and his other replies in regard to the numbers of the salmon caught were of the same character. However, the general impression left on our minds was that a great many salmon were caught here during the entire spawning season, possibly enough to warrant the establishing of a hatching station at the mouth of the Little Spokane.

Leaving the subject of the Spokane River here, I will remark upon the other streams flowing into the Columbia below the mouth of Snake River, and will return to discuss more fully the expediency of operating on the Spokane.

As before mentioned, the transcontinental railroad, after leaving the Spokane River, crosses the great plain of the Columbia and the dry bed of the ancient Lake Lewis, and does not strike the Columbia or any of its tributaries until it reaches the mouth of Snake River. From the mouth of Snake River it follows the Columbia down past The Dalles* and through the Cascade range of mountains almost to its terminus at Portland.

Of course the Columbia itself below Snake River, and Snake River anywhere near its mouth, are not to be thought of in connection with

* To avoid giving a wrong impression, perhaps I had better state here that the Northern Pacific Railroad proper terminates at Wallula Junction, Wash., at the mouth of the Walla Walla River, and that thence to Portland the railroad is owned and operated by the Oregon Railroad and Navigation Company.

a salmon-breeding station, their great volume and width making it wholly impracticable to collect any large number of spawning salmon from them. Below Snake River on the north or Washington side of the Columbia there are many salmon streams flowing into it, as Alder Creek, Klikitat River, Wind River, Washougal River, Lewis River, and Cowlitz River, besides many others; but, with the exception of perhaps the Cowlitz and Klikitat, they are all short, diminutive rivers which would never furnish breeders enough to supply any great number of eggs, and although the Cowlitz and Klikitat are of greater size and would yield a larger supply of eggs, they nevertheless could not furnish enough to warrant the establishment of a salmon-breeding station anywhere along their course. On the south or Oregon side of the Columbia its tributaries are much larger, but each one of them is open to some objection which would be fatal to the collecting and distributing of salmon eggs on a large scale.

The first river below Snake River, on the Oregon side of the Columbia, is the Walla Walla.* This river, although on the same side of the Columbia that Oregon is, is nevertheless in Washington Territory, as the Columbia from the mouth of the Snake River to a few miles below Wallula lies wholly in Washington Territory. The larger affluents of the Walla Walla River rise in the Blue Mountains, about 100 miles east of the Columbia. About 15 miles from the Columbia they become united, and now, under the name of the Walla Walla River, their combined waters empty into the Columbia at Wallula Junction. Although several persons have recommended the Walla Walla as a good river for our purpose, and although in times of high water many salmon run up this stream, it is nevertheless, I am convinced, too small a river to conduct any large operations on in the way of collecting salmon eggs. The river is scarcely more than 60 feet in width at low water, and shallow a quarter of a mile from its mouth; and a river of this size would not carry a sufficient volume of water to induce salmon enough to enter it to furnish any great number of eggs in these times of canneries; for it should be remembered that the immense canning operations carried on along the Columbia River have entirely revolutionized matters, as far as the abundance of salmon eggs is concerned. Twenty years ago, before the business of canning salmon on the Columbia was inaugurated, salmon literally swarmed up all the small creeks and little tributaries of the main river in such immense quantities that several million eggs could, without doubt, have been easily collected from the spawning fish at the head of comparatively insignificant streams; but that day has gone by, probably forever. The vast number of nets that are being continually dragged through the water at the canneries on the main river during the fishing season catch millions of full-grown salmon on their way up the river to spawn, and of course reduce to a corresponding extent the number of parent fish that reach the spawning-grounds.

* Three hundred and twenty-five miles from the mouth of the Columbia.

The comparatively few that succeed in running the gauntlet of the innumerable nets in the main river would, if they could be gathered together at one spot, still be enough to supply a great many million eggs; but those which ascend the river above the nets, instead of all going to one place, separate and divide up among the hundreds of tributaries, large and small, that help to form the great Columbia. Consequently a very small percentage, indeed, of the few salmon that get by the nets are to be found in any one manageable stream, unless some peculiar natural causes exist at some specified place to make that point an exception to the general rule. It is accordingly useless to look now to small streams which are subject to ordinary conditions for a large supply of salmon eggs, however abundant the salmon used to be in them in the former and better days of these salmon rivers.

The same objection which applies to the Walla Walla applies also to the Umatilla,* which is the next river entering the Columbia from the south. This river is much larger than the Walla Walla, but is not large enough to induce many salmon to leave the Columbia and ascend its current. In 1877, I was told that this river would be a good one for salmon-breeding, but a thorough investigation of it proved the contrary. I built across the river, about half a mile from its mouth, a rack similar to that which we are accustomed to put across the McCloud River in the spawning season in order to arrest the course of the salmon, and had it watched for two or three months in order to ascertain the magnitude of the salmon run. The result was that the run proved to be wholly inadequate for the collecting of a large number of eggs. So the Umatilla was abandoned.

Willow Creek comes next to the Umatilla, but is even smaller than that river, and consequently may be considered entirely out of the question.

The John Day River,† which comes next, rises in the Blue Mountains and, swollen by many tributaries, empties into the Columbia about 65 miles below the Umatilla. This river is large enough, but there are no accessible places on any part of it where fishing for breeders could be successfully carried on. At some future day, when railroads have become more abundant in Oregon, a suitable place may be found on the John Day which would also be accessible, but there are none at present.

Seventeen miles below the John Day River, the Deschutes‡ empties, splashing and foaming over the rocks, with a rapid current, into the Columbia. This river heads in the Cascade Range, at Mount Theilsen, nearly as far south as the forty-third parallel, while a more eastern branch arrives from as far east as the southwestern spurs of the Blue Mountains. The Deschutes is a model salmon river, cold, large, and

* Three hundred and two miles from the mouth of the Columbia.

† Two hundred and thirty-eight miles from the mouth of the Columbia.

‡ Two hundred and twenty-one miles from the mouth of the Columbia.

wide, rising in high mountains, flowing with a swift current, and finally emerging from its deep-sided cañon with great force, where it plunges into the Columbia River. It may not be generally known that a strong, rapid current of cold water is the most effective agent there is for inducing breeding salmon to turn from their course up a large river. It is very much a matter of chance whether they enter a river, even a large one, which is still and deep at its mouth. Such tributaries will certainly not attract the salmon into them from any great distance out in the main river. The Umatilla is a stream of this character; also the Willamette, and to some extent the Cowlitz. Many of the Columbia River salmon that are pursuing their upward course near the south bank of the river will very likely, when they reach these streams, be following the shore line, and in that way may be led into these rivers; but the salmon that are coming up on the other side of the Columbia, or are pursuing a middle course, will keep their course and disregard these streams that make so little impression on the main river. But such rivers as the Deschutes, which pour a cold, vigorous, swift-running volume of water into the main river, that makes itself felt to the further shore and for many rods below its mouth—such rivers call salmon up their channels by shoals, not only from their own side of the river but also from the opposite shore. These rivers always have a great run of salmon, and the Deschutes on this account would be a favorable stream to operate upon for collecting salmon eggs were it not for one drawback, and that a serious one, viz., It is unmanageable, for it is too large and violent a stream to control. As, I think, I have previously explained, the mere fact that the conditions for drawing a net in a salmon river are favorable does not by any means make it a favorable place for a large salmon-breeding station. To secure the necessary conditions of success, the river must be of such a character that the salmon can be stopped in some good seining place by erecting a temporary obstruction across the river. This could not be done on the Deschutes except at a very great expense. About 30 miles up the river, however, at a place called the "crossing" of the Deschutes, or sometimes simply Deschutes, there is a high fall which, except at very high water, keeps the salmon from going up any higher. Here the conditions are reversed. If now the river below was quiet enough to allow the successful drawing of the seine, this would be a good place for a breeding station, but the river here passes through a high rocky cañon with such violence as to render the drawing of a net impracticable. There are some other objections of less importance, but the one mentioned is enough. This point might, nevertheless, be a favorable one, if the falls themselves and the land around the falls could be secured, but this spot has been taken up by a settler who moved there many years ago and who now holds the premises at so high a figure as to make it very desirable to find a place somewhere else if possible.

The next large stream down the Columbia is the Big Sandy, which is a good salmon river, and probably has towards its headwaters some

favorable places for collecting salmon eggs, but at present they are not easily accessible. About 20 miles below the Big Sandy, the Willamette* slowly discharges its immense volume of water into the Columbia, which here seems not much larger than itself. If the slow Willamette poured its great stream into the Columbia as rapidly and forcibly as the Deschutes does, probably more than half of the Columbia River salmon would turn aside into the Willamette, but the Willamette is so still and apparently so almost motionless where its waters join those of the Columbia that but few salmon, relatively speaking, ascend the Willamette. Most of those entering the river find their way up past the city of Portland, and on 12 miles further to the Clackamas. This is a cold, swiftly-running river that empties into the Willamette just below Oregon City; its cold, swift current, which heads in the snow-covered flank of Mount Hood, attracts a large proportion of the salmon from the larger but warmer river, and even those that go by go only half a mile further, where their course is abruptly checked by the Oregon City Falls, which, at most stages of water in the river, entirely prevent the salmon from going any farther up. The salmon thus arrested in their upward progress along the Willamette, after making ineffectual attempts to jump the falls, after awhile drop back discouraged as far as the mouth of the Clackamas, and as soon as they feel again the cold vigorous rush of the Clackamas, immediately shoot up this river and join the great army of salmon that have preceded them up the same river. It will be inferred from this description that most of the salmon coming up the Columbia finally find their way into the Clackamas. This inference is entirely true. It was this which led to the establishment of a salmon-breeding station on this river in 1877 by the Oregon and Washington Fish Propagating Company. This station, which a series of misfortunes caused to be finally abandoned, is undoubtedly well situated for the taking of a great many salmon eggs. It is, however, somewhat difficult to operate it, and perhaps it will be found that some other point farther up the basin of the Columbia will combine many of its advantages without being subject to its disadvantages.

From the mouth of the Willamette to the sea all the streams emptying into the Columbia are short and small, and there are none which would command a moment's attention as a suitable place for a large salmon-breeding station.

From what has been stated above, it will be seen that from the head of the North or Clarke's Fork, which forms one of the two great arteries that combine to form the Columbia—the Snake River being the other—and which rises in the Continental divide of the Rocky Mountains between Deer Lodge and Helena, Mont., to the Pacific Ocean, there is not a place lying near the line of the Northern Pacific which unites all the conditions required for the carrying on of a salmon-breeding station on a large scale, except possibly the one referred to on the Little Spokane

* One hundred and eight miles from the mouth of the Columbia.

River. Some places supply some of the requisite conditions, others furnish what these have not, but none of them, with this one exception, combines all the needful conditions.

It seems surprising at first that this should be so. It seems surprising that there are not many points along the hundreds of miles of the Columbia and its northern fork where plenty of salmon eggs could be obtained and distributed, but nevertheless there are not. As this presents such a curious and interesting question, let us glance for a moment at the conditions that are required for the operating of a large and successful salmon-breeding station; and in order to bring out the subject with more distinctness, I will enumerate these conditions and consider them in regular order. Taking them in the order of their relative importance they seem to present themselves nearly as follows:

1. Abundance of breeding salmon.
2. Accessibility of location.
3. An adequate supply of water.
4. Convenience of location for obtaining water.
5. Availability of location.
6. Facility for catching parent fish.
7. Facility for arresting the upward progress of the breeding salmon.
8. Security from high water and attendant dangers.

1. **ABUNDANCE OF BREEDING SALMON.**—This first condition, viz., of the presence of an abundant supply of salmon, is such an obvious one that nothing more need be said about it. Of course there must be plenty of salmon, for a salmon-breeding station without the salmon would be like the play of Hamlet without the part of Hamlet. The Umatilla and Walla Walla Rivers are examples of rivers possessing all the conditions just enumerated, except this one—an abundance of salmon.

2. **ACCESSIBILITY OF LOCATION.**—Hardly less indispensable than the abundance of salmon is the accessibility of a salmon-breeding location. If it is so far removed from the traveled thoroughfares that the station could not be built, nor the eggs distributed, except at a cost that would practically be a prohibitory one, the location is of course of no value, no matter how abundant the salmon are or how favorable the other conditions may be. Several places on the great bend of the Columbia, between Priest Rapids and Lake Pend d'Oreille, which cannot be approached within 50 or 100 miles, except by very bad roads and trails, are illustrations of the absence of the essential element of accessibility.

3. **AN ADEQUATE WATER SUPPLY.**—Next in rank of importance seems to come the presence of a sufficient and suitable supply of water for hatching. Where this condition is lacking it is hardly worth while either to go to the expense of putting up hatching works or to make the attempt to collect a large number of eggs; for although, provided there is a considerable water supply, a correspondingly large number of eggs may often be matured for shipment or hatched, nevertheless an inadequate supply of water is not only always a source of care and uneasiness,

but is also a standing temptation to the operator to hatch more eggs than it is capable of doing. The result of this, of course, is usually a disastrous loss. Then, again, if a dry season should come, or one otherwise unfavorable to the supply of water, that season might prove almost an entire failure. It is consequently hardly desirable to undertake the hatching of salmon on a large scale without being sure of having plenty of water. Indeed, to be short of water in the hatching season is so annoying, not only from the causes just mentioned, but for various other reasons, that I would not want to have anything to do with a hatchery that did not have a large, superabundant, and unfailing supply of water. The first station of the United States Fish Commission on the McCloud River was a very good example of the absence of this condition. The station combined almost all the conditions except this one, and those who carried it on the only season that it was in existence will never forget the great care and anxiety that were caused by the insufficient supply of water, or the alarm that was always felt when hot and dry weather shrunk the little supply that we had, and there was danger that all the eggs would be lost in consequence.

4. CONVENIENCE OF LOCATION FOR OBTAINING SUITABLE WATER.—This condition may seem at first sight to be identical with the last, but a second look will show that it is not only a different one, but one that may often be wanting where the other is unexceptionable. This is not an uncommon occurrence. You may have a large river full of salmon, plenty of water, and plenty of fish, and not be able to use any of the water for hatching the eggs that are taken. I refer now to an automatically provided supply of water. For I am, of course, aware that wherever there is water it can be raised to any reasonable height by steam-pumps and other agencies; but steam-pumps are expensive to begin with; they involve a current expenditure in the running of them, and are never wholly free from risk. It is consequently always desirable to provide the water for a hatching station automatically, and no place where this cannot be done can be said to combine all the conditions desirable for a successful hatching station.

It sometimes happens that sufficient water can be brought to the hatching house without much inconvenience, but owing to its becoming warm or muddy on its way it may be unfit to use after it reaches there. It also happens sometimes that, although abundant and suitable water for the hatching house may be very near, there may be great inconvenience and risk in bringing it to where it is wanted. It is consequently quite important in selecting a hatching station to find a place where the water can not only be found in abundant supply, but where it can be conveniently brought to the hatching house in suitable condition. Probably more ingenuity has been exercised by fish-breeders in their contrivances for bringing suitable water to their hatching houses than in any other department of their operations. Windmills, steam-pumps,

current-wheels, hydraulic rams, siphons, and about all of the more common appliances for raising water to a higher level have been resorted to, in order to utilize what was otherwise a good breeding spot with plenty of water for the fish to live in. This fact shows how desirable it is to have a breeding place where the hatching water comes naturally to the eggs and involves no expense in obtaining it.

The salmon-breeding works that were put up in Oregon, on the Clackamas River, in 1877, for the purpose of hatching Columbia River salmon, furnish a singular illustration of this. The spot selected for this station seemed to be favorably situated for the work, particularly in regard to the water supply for the eggs, for just behind the site of the hatching house was a large stream of water called Clear Creek, which furnished an unlimited supply of good water at a suitable height to be introduced into the hatching house. When, however, we came to undertake to dam up the creek for the purpose of taking water from it, it was found that the bed of the creek was quicksand to an indefinite depth, and that neither hard-pan nor bed-rock could be reached. Consequently, after various persistent but fruitless attempts to find a secure place across the creek for a dam, the creek as a water supply for hatching had to be given up. Water for the purpose was afterwards obtained the same year by other means, but only with considerable difficulty and at a large expense; and when the company which built the establishment concluded the next season to risk the experiment of damming up Clear Creek, the first large freshet carried away the dam and left the salmon eggs in the hatching house without water, which resulted in a serious loss.

5. AVAILABILITY OF LOCATION.—It would seem at first sight as if any favorable location for a salmon-breeding station would be available, but this is far from being the fact. For instance, some falls might be found in a good salmon river where every facility could be afforded for taking and hatching eggs, but if these falls belonged to some one who had taken up a claim there, the site could not be secured perhaps, except at an enormous price or an enormous rental, which would practically place it out of reach. Or, perhaps, a good place could be found on a river which was considerably settled above the proposed site of the fishery. This would also make it unavailable, because the upper settlers would in all probability never allow a dam to be put across the lower portion of the river to obstruct the ascent of the salmon, and without such obstruction no great quantity of salmon could be taken anywhere in the United States at least, unless it might be at the foot of some falls or natural obstruction.

If we needed an example to illustrate the absence of this condition we might find it at the crossing of the Deschutes River, where the falls which stop the salmon and where the land adjacent, are owned by a settler and held by him at a very high figure; or on the Little Sacramento, in California, where many salmon eggs could be taken and hatched if

a dam was put across the river, but where the settlers are so numerous above that such an obstruction would not be tolerated.

6. FACILITY FOR CATCHING PARENT FISH.—This is not so essential a condition as the preceding ones, because labor and dynamite can usually create a good seining ground almost anywhere. It is an important condition, however, because a poor seining ground is a great drawback and a very serious annoyance at a salmon hatchery, and in many places it would cost a great deal of money to make a good seining ground with labor and dynamite. Moreover, such artificially prepared grounds are torn to pieces, so to speak, every winter by the violence of the high water during floods. This difficulty of securing a good natural seining ground is more often encountered than one would suppose. An inexperienced person might perhaps think that a net could be dropped anywhere in a river where fish abounded, and be drawn in successfully. But it is not so. Indeed there are many things which bar out seining in a river. For instance, a seine cannot be hauled with any success in a swift and shallow place, for the net cannot be drawn inshore with any success, even supposing the river bottom to be comparatively smooth and level. Neither is it of any use to haul where there are deep holes in the river bed, for the fish will go into the holes as the seine passes over them, and will escape. Again, it is impossible to haul a seine where there are large bowlders, or worse still, projecting points of rock in the seining ground, as these obstructions will foul the net every time, and if the fishing is persisted in will soon tear the net to pieces. As suggested above, a sufficient expenditure of time and money will make a good seining ground out of a poor one, but it is often a very expensive undertaking, and when accomplished the seining ground that has in this way been artificially made will never be so good a ground for fishing as one that has been prepared, or nearly prepared for use, by nature.

As an example of the difficulty of finding a good seining ground I might mention the McCloud River, California, where, I suppose, there is not in the whole sixty miles of the course of the river a single place where there is a good seining ground or where a first-class seining ground could be made, except at the salmon-breeding station of the United States Fish Commission two miles from the mouth of the river.

7. FACILITY FOR ARRESTING THE PROGRESS OF THE BREEDING SALMON UP THE RIVER.—As every one knows, migratory fish, particularly those of the salmon family, develop an irrepressible instinct to ascend the rivers which contain their spawning grounds. So strong and violent, indeed, is this instinct in salmon that they will force their way over all obstacles not absolutely insurmountable, in their endeavors to reach the sources of the rivers which they enter to deposit their spawn. Taking advantage of this instinct, the salmon-breeder finds an easy method for holding them at the particular place where he wants them to stay, by throwing across the river a dam or fence, which allows the water to pass down but prevents the salmon from going up. Their in-

stinct keeps them from going down the river, and the obstruction keeps them from going up the river, so that they are practically confined or, as the Californians say, "corraled" in the river just below the dam. The dam is usually constructed just above the fishing ground, where the fish collect in great numbers, and where they are not only safely confined but easily caught. This method of collecting the parent salmon during the spawning season in one place by putting an obstruction across the river is absolutely indispensable for taking eggs in great numbers (unless nature has already provided an equally effective obstruction), for all the salmon, even in the most favorable localities, that could be caught while passing on their way up the river would never be enough to furnish any very large quantity of eggs. Now, in selecting a site for a salmon-breeding station this consideration must always be borne in mind, for it is an essential condition of success. I need hardly say that across many rivers, especially the large and rapid ones, it is impracticable to place such an obstruction as has just been mentioned; and many a good salmon river has been abandoned as a good breeding point because, although salmon enough ascend the river, they could not be collected together in sufficient numbers anywhere, owing to the impracticability of constructing a dam or fence across its channel.

8. SECURITY FROM HIGH WATER AND ITS ATTENDANT DANGERS.—This is the last prerequisite of a salmon-breeding station which I will mention, but it is not by any means the least, nor is it a very easy one to secure. I know of but very few good salmon rivers that are not subject to dangerous and unmanageable freshets, and of course no prudent person would knowingly build a station that could be destroyed or rendered useless by high water. It might perhaps be carried on for one or two seasons, but it is naturally only a question of time when great mischief would be caused. Sooner or later the rise in the river will come and calamity will ensue.

THE LOCATION AT THE MOUTH OF THE LITTLE SPOKANE RIVER.

I return now to the consideration of the qualifications of the mouth of the Little Spokane River as a suitable place for conducting large operations in collecting and distributing salmon eggs. I think it is safe to say that we are sure that this point combines all the favorable conditions just enumerated, with possibly the very important exception of the first and most essential one of all, viz., the abundance of breeding salmon. This was a question which could not be determined during my examination of the place in July, because the run of breeding salmon does not reach the Little Spokane until August, September being probably the month when the spawning salmon are most abundant. All the information we could collect on this very essential point of the abundance of salmon in the breeding season was what the Indians gave in their vague and unsatisfactory way, and, although this informa-

tion left the impression that a great many salmon came up in August, it by no means amounted to establishing a certainty.

With a view to obtaining more precise data on this subject, I engaged a man living at Spokane Falls to collect statistics in regard to the number of salmon caught by the Indians during the fall run. The statistics which were collected, however, are not by any means such as the exigencies of the case require. The Indian's information, given with the customary Indian explicitness, was that the salmon were as "thick as crickets," which means, of course, that they were very numerous, but might be intended to mean 1,000 or 50,000. Taking the most accurate statements that could be obtained and basing a fair calculation upon them, it appears that about 2,000 salmon were actually caught by the Indians this season (1883) at the mouth of the Little Spokane, and it is possible that many more than this number were caught. I should think that with white men's appliances and improved facilities for their capture the number of parent salmon caught by the Indians might be doubled. This would make 4,000 breeding salmon to operate with, which would give a yield probably of from five to ten million eggs. I do not wish to be understood that this is my opinion about it. I only say that if the statistics collected this year should prove reliable, there is a fair prospect of getting from five to ten million salmon eggs at the mouth of the Little Spokane during the spawning season. I consider, however, that the question of the abundance of the salmon at this point is far from being settled.

In the meantime, let us see how the mouth of the Little Spokane meets the other requirements of a large salmon-breeding station. Taking them in the order in which they have just been enumerated, accessibility of location comes next to the abundance of fish. Here the location at the Little Spokane possesses extraordinary advantages. Eight miles from the mouth of the river, over a remarkably hard and level road, is the town of Spokane Falls, a new but thriving and promising settlement of perhaps 1,200 inhabitants. This town is situated on the line of the Northern Pacific Railroad, and is in daily connection with the rest of the world by mail, telegraph, and railroad, the railroad being one of the great transcontinental thoroughfares of the country. These general facts alone are sufficient to show the accessibility of the location without the necessity of mentioning details.

The water supply at the mouth of the Little Spokane for hatching the eggs is practically unlimited. As there is a strong current in the river, and the water does not rise till after the spawning season and hatching season are over, the water can be raised safely from the river itself by a current-wheel, as at the McCloud River station, and this being the case, any required quantity of water can be brought to the hatching house at a small expense.

The location is also favorable for obtaining water conveniently. The river never rises more than a few feet, and consequently the hatching

house can be erected not very far above the low-water mark. A small current-wheel will therefore be sufficient to raise the water to the hatching house, and the adjacent land is so favorable for building on, that the wheel can be placed very near the hatching house, which will render unnecessary the construction of a long flume from the wheel to the hatching house. As the river does not rise till the hatching season is over, the wheel need not be protected from drift-wood or arranged with reference to the rising and falling of the water. These are great conveniences, and, on the whole, it may be said that the water supply may be safely depended upon in every respect.

The location is also remarkably favorable as to availability. Fortunately the adjacent country is still in its primitive state. When I visited the place in July (1883) many Indians were encamped on the river bottoms, but I saw no white men. It is true some claims near the river have been taken up by white men, but they are not valuable, and could be bought without much expense. It is therefore very probable that the site of a salmon-breeding station could be obtained without much cost; and as there are very few settlers up the river, and no towns or villages, no objection would probably be raised to obstructing the ascent of the salmon during the spawning season by a dam across the river.

The Little Spokane is also of such a character that it would be an easy matter to capture the breeding fish. Indeed, I think a seining ground could be arranged, so that nearly all the spawning fish that came up the river could be caught; and furthermore, it being close to the main Spokane River, it would not be difficult to run two seining grounds—one in each river—which would undoubtedly somewhat increase the yearly catch of breeders.

It will be a very easy matter to build a dam or salmon-rack across the river to keep the breeders on or near the seining ground. Indeed, the frail structure which we saw Indians successfully erecting across the river shows how easy it would be for white men, with their superior appliances, to put a salmon-rack across the river, such as would be required to answer the purposes of a salmon-breeding station. There being no drought or freshet on the river during the season's operations at the station—and indeed no natural changes at all in the river—a very simple and easily constructed dam would be perfectly safe. This is a great advantage, as it often proves a very difficult matter in a river subject to freshets in the hatching season to put in an obstruction that is perfectly safe.

And last, but not least, the maximum rise of the river during the year is so inconsiderable that there will never be any danger of the hatching house and other buildings being washed away, even if they are placed, as it is desirable they should be, close to the river.

Besides possessing the essential qualifications just enumerated for a salmon-breeding station, the Spokane location has many convenient

features about it to recommend it. In the first place, it is in a good timber country, where lumber can be easily and inexpensively obtained for building. Then the roads in all directions are hard and good, even during the rainy season, which is an advantage that can be fully appreciated by those who have lived in other parts of the Pacific coast, where the roads become practically impassable during the rainy season on account of the great depth of the mud. The ground is also almost level from the mouth of the Little Spokane to the town of Spokane Falls, which would make communication with the town and freighting to and from the breeding station very easy. The climate also is a great recommendation to this place; as it is never very cold or very hot.

By glancing over what has just been said about the mouth of the Little Spokane it will be seen that it is known to be, in all the essential points but one, an unusually favorable location for a salmon-breeding station. If it should prove to be capable of furnishing an abundance of breeders, I should not hesitate to recommend it emphatically as one of the best situations to be found anywhere for taking and distributing salmon eggs. If, however, it should fail to supply the required quantity of spawning salmon, I do not know where we could look for any one place on the Columbia River or its North Fork which by itself would be adequate and satisfactory, and I think we should then be reduced to the necessity of going farther from the railroad or erecting two or three separate stations at different points. Of these two alternatives it would probably be most prudent to choose the latter, on account of the extreme difficulty of constructing a station for carrying on the work of taking, distributing, and hatching salmon eggs at any great distance from the railroad.

I think it proper to state here that perhaps the finding of another such place as the McCloud River station, in California, should not be expected. It may be that the McCloud River station has spoiled us for all other places by leading us to expect too much. Possibly there are no other places in the United States, Alaska excepted, where nearly twenty million salmon eggs could be obtained in one year*. It certainly is not reasonable to expect such a combination of favorable circumstances to occur again as is found at the McCloud station. It is a combination, against the second occurrence of which there are many chances to one. In the case of the McCloud station, it so happened that all the other main tributaries of the Sacramento, with one or two exceptions, were so filled with the mud and dirt ("slickens") from the hydraulic mines above that no salmon would enter them. These rivers were as completely closed to the spawning salmon as if an impassable dam had been built at their mouths on purpose to keep them out. The consequence was that all the salmon passed by them, and, the McCloud

* In 1873, 14,000,000 salmon eggs were placed in the hatching house at the station on the McCloud River, California, and several millions more could undoubtedly have been obtained if needed.

being the coldest and most inviting of the tributaries that were left, they swarmed up this river in vast quantities.

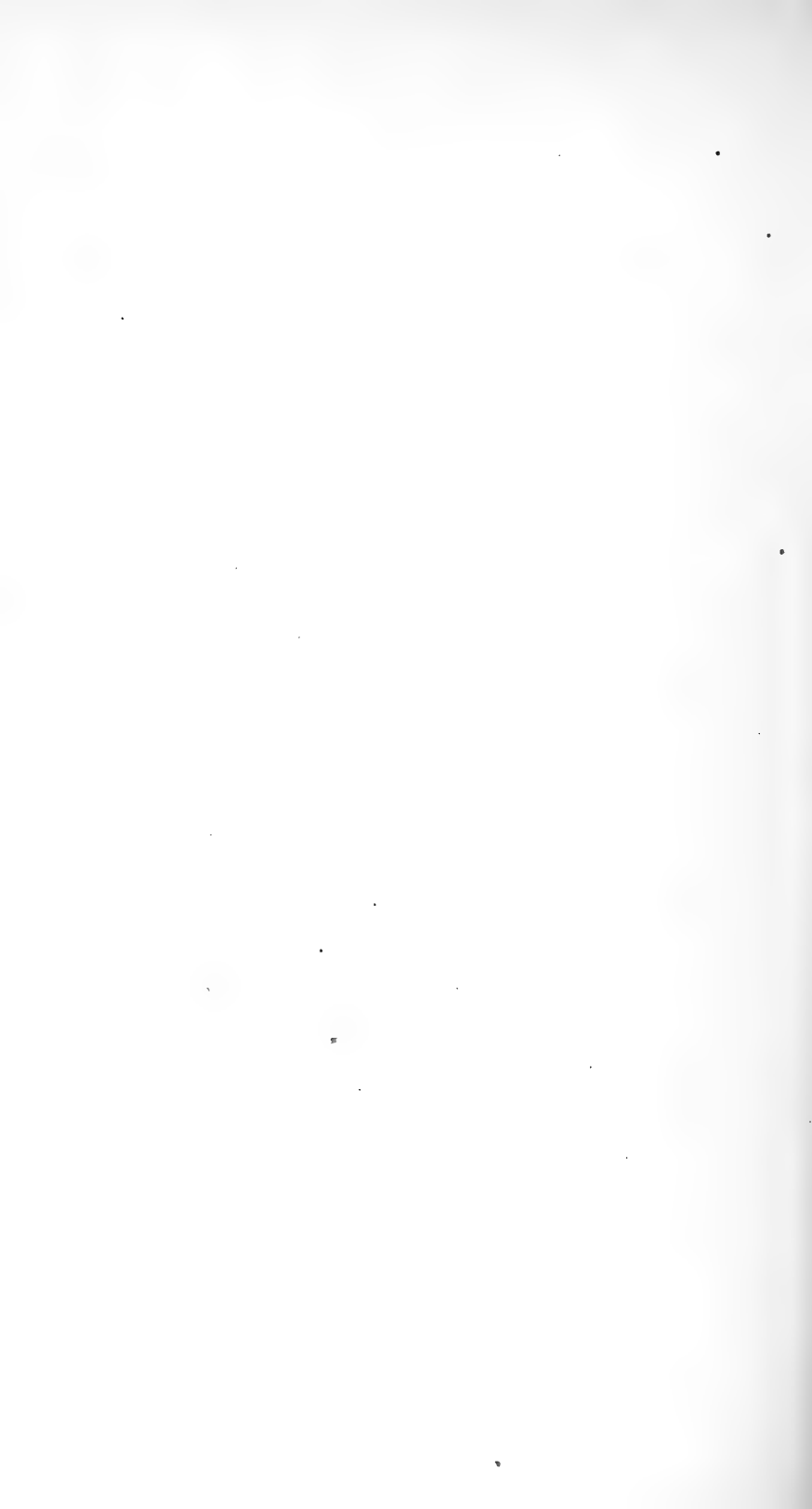
Besides, a good seining ground being found at the junction of the river with the California and Oregon stage line, the station was enabled to be built at a convenient place for communication with the outside world. A good place was found for putting a rack or fence across the river just above the seining ground, so that the vast hosts of salmon going up the river were stopped just where they were wanted most. There was an abundance of good water for hatching and it was easily obtained. All the land about the river was wild land, so that the site of the fishery cost nothing, and no one objected to the rack that was put across the river to stop the salmon, because only one white man lived up the river. Here was a collection of first-class qualifications which it is obvious would be extremely unlikely to be found combined together again, and it is possible that, in point of fact, no other such place will be found again south of the British possessions. If this should prove to be the case, then we should have to be satisfied with stations of smaller capacity and more of them, unless, as just suggested, it is thought desirable to go to a greater distance from railroad communication. In the meantime it seems safe to say that the mouth of the Little Spokane River appears at present to be the most favorable point now known for establishing a salmon-breeding station on the Columbia or its tributaries, which shall at the same time be near the line of the Northern Pacific Railroad.

I wish to add, however, that if Washington Territory and the State of Oregon, between which the lower Columbia flows, could agree upon a code of good protective laws for the salmon, the Clackamas River would again teem with salmon as before, and in that event perhaps the best point for a breeding station would be on that river where the station of the Oregon and Washington Fish Propagating Company was built in 1877. Before the times of canneries and excessive netting of the salmon in the lower Columbia, the Clackamas in Oregon was as good a salmon river as the McCloud in California, and if the salmon should ever be allowed to reach it, it might be again. There is no ground for the objection that the Clackamas salmon are an inferior variety of fish, for it has been proved repeatedly and indisputably that the Clackamas salmon are the Spring or Chenook salmon (*Oncorhynchus quinnat*) [*O. chowicha* (Walb.) J. & G.], and of precisely the same variety as those which are canned at the mouth of the Columbia, and which are held to be of the highest value for canning. Nor is the difficulty of obtaining water for the hatching house at this point a very serious objection, for if an abundance of breeders could be obtained it would warrant the incurring of sufficient expense to overcome this difficulty. If, therefore, the laws should ever protect the salmon of the Columbia, so that they could reach the mouth of the Clackamas, it might be found

the most feasible plan for obtaining salmon eggs on a large scale to restore the old breeding establishment on this river.

On my return from California, in September, 1883, so favorable an opportunity was offered for making some investigations in regard to the run of salmon in the upper tributaries of the Snake River or South Fork of the Columbia that I somewhat exceeded my instructions, which limited my inquiries to that portion of the Columbia River which lies along the line of the Northern Pacific, and went to Eagle Rock, Idaho, where the Utah and Northern Railroad crosses the Snake River, with some hope of finding a suitable place for salmon hatching, but to my surprise I found that no salmon ever came up as far as Eagle Rock. At Pocatello, Idaho, which is the junction of the Utah and Northern Railroad and the Oregon Short Line, I found also that no salmon came up to American Falls, which is 25 miles below Pocatello. In fact, all salmon are stopped in their progress up the Snake River at the Great Shoshone Falls, in Idaho, which are about 80 miles from the American Falls and 107 miles from Pocatello. These falls are very high, and the salmon cannot get over them. The falls are not directly on the line of the railroad, but are 27 miles from the track of the Oregon Short Line Railroad, the point from which they are most accessible probably being the station of Shoshone. At these falls the salmon, I was told, collect in great numbers, and it is likely that this point may be found to be a good place for establishing a station for collecting salmon eggs and for hatching them.

I will close by mentioning one more place in this connection, which may some time be found to be a favorable place for a station. This is Salmon City, on the Salmon River, in Idaho. I have the authority of Captain Bendire for stating that salmon can be found here in great quantities in the spawning season, and it probably has other desired qualifications, but it is 100 miles from the nearest railroad point, from which it is reached by a rough and hilly road. If it was not for this objection, a salmon-hatching station might be established here, but its comparative inaccessibility is a serious drawback to the location, and it ought not to be taken into consideration while other good and more accessible points can be found.



INDEX.

[NOTE.—The references are to page-figures, in brackets.]

	Page.		Page.
Ainsworth, Wash.....	2, 4	Klikitat River.....	6
Alder Creek.....	6	Lewis Lake.....	5
American Falls.....	19	Lewis River.....	6
Bendire, Captain.....	19	Little Spokane, breeding salmon in.....	14
Big Blackfoot River.....	1	Little Spokane, establishing hatching station on.....	5, 14, 15, 18
Big Sandy, good salmon river.....	8	Little Spokane River.....	5, 9, 10, 16, 17
Bitter Root Mountains.....	1	Little Spokane River, maximum rise of.....	16
Bitter Root River.....	1	Little Spokane, salmon at mouth of.....	5
Blue Mountains.....	6, 7	Little Spokane water supply for hatching eggs.....	15, 16
Breeding fish, capture of.....	16	Little Sacramento, salmon eggs taken in... ..	12
Building, cost of.....	17	Low-water mark.....	16
Cabinet Rapids.....	4	Location, accessibility of.....	10
California and Oregon stage line.....	18	Lower Columbia River.....	18
California, return from.....	19	McCloud River.....	7, 11, 18
Canneries.....	18	McCloud River, seining ground.....	13, 18
Cascade Range.....	5, 7	McCloud River station.....	15, 17
Clackamas River.....	9, 12, 18	Mahkin Rapids.....	4
Clarke's Fork of the Columbia.....	1, 2, 4, 9	Mississippi River.....	1, 2
Clear Creek.....	12	Missoula, Mont.....	1, 2
Cœur d'Alène Lake.....	4	Missoula River.....	1, 2
Cœur d'Alène Mountains.....	1	Missouri River.....	1
Columbia River.....	2, 4, 8, 9, 17	Mount Hood.....	9
Columbia River, explorations on.....	1	Mount Theilsen.....	7
Columbia River, salmon.....	8, 9, 12	Net drawing in a salmon river.....	8
Columbia River, salmon canning.....	6	Nets in Columbia River.....	6
Columbia River, station on.....	4	North Fork.....	9, 17
Colville River.....	4	Northern Pacific Railroad.....	2, 4, 5, 9, 15, 18
Continental divide of Rocky Mountains.....	2, 9	Oncorhynchus chouicha.....	18
Cowlitz River.....	6, 8	Oncorhynchus quinnat.....	18
Current-wheels.....	12	Oregon and Washington Fish Propagating Company.....	9, 18
Deer Lodge.....	2, 9	Oregon City.....	9
Deer Lodge River.....	1, 2	Oregon City falls.....	9
Des Chutes the, a model salmon river.....	7, 3	Oregon fish laws.....	18
Des Chutes River, falls of.....	12	Oregon Railroad and Navigation Company.....	5
Eagle Rock.....	19	Oregon, railroads in.....	7
Fish-breeders.....	11	Pend d'Oreille Cañon.....	4
Flathead River.....	1	Pend d'Oreille Lake.....	2, 10
Foster Creek Rapids.....	4	Pend d'Oreille Lake, salmon caught in.....	3
Grand Rapids.....	4	Pend d'Oreille River.....	2
Great Shoshone Falls, in Idaho.....	19	Pocatello, Idaho.....	19
Hatching-house.....	15, 16	Portland.....	5, 9
Helena, Mont.....	9	Priest Rapids.....	4, 10
Hellgate River.....	1, 2	Railroads.....	19
Hydraulic mines.....	17	Rock Island Rapids.....	4
Hydraulic rams.....	12	Sacramento, tributaries unsuitable for salmon.....	17
Indians fishing for salmon.....	5, 15	Saint Anthony Falls.....	2
Indians on Pend d'Oreille River.....	3		
Indians using salmon-trap.....	5		
John Day River.....	7		
Kettle Falls.....	4		

	Page.		Page.
Saint Louis	2	Sand Point	2
Salmon	8	Seine, conditions for hauling	13
Salmon, abundance of	10, 14	Seining ground	13
Salmon-breeding station	1	Seniakwoteen	4
Salmon-breeding station:		Seniakwoteen Falls	3
adequate water supply for	10	Seniakwoteen, impracticable for a salmon	
availability of location	12	hatchery	3
conditions necessary for	10	Shoshone	19
convenience of	11	Siphons	12
cost of site	16	Slickens	17
facility for catching parent fish	13	Snake River	2, 4, 5, 6
high water, security from	14	Snake River, run of salmon in	19
in Oregon	12	Spawning season	14, 16
on Clackamas River	9	Spokane Falls	5, 15, 17
qualifications for	16	Spokane River	4, 5
salmon for	10	Steam-pumps	11
selecting a site for	14	Stone, Livingston	1
United States Fish Commission	13	Suckley, Dr	2, 5
Salmon City, favorable for a station	19	The Dalles	5
Salmon, collecting of	14	Umatilla River	7, 10
Salmon caught in Little Spokane River	15	Umatilla, salmon run	7
Salmon eggs, collecting and distributing	14	United States Fish Commission	11
Salmon, facility for catching	13	Walla Walla River	5, 6, 7, 10
Salmon, netting of	18	Walla Walla River, description of	6
Salmon, protective laws for	18	Walla Walla River, salmon run in	6
Salmon rack	16	Wallula Junction, Wash	5, 6
Salmon River	19	Washington Territory fish laws	18
Salmon rivers	7	Washougal River	6
Salmon rivers, floods on	14	Whirlpool Rapids	4
Salmon, scarcity of	3	Willamette River	8, 9
Salmon, spring or Chenook	18	Willow Creek	7
Salmon streams	6	Windmills	11
Salmon, winter's stock of	5	Wind River	6

IV.—THE BRITISH SEA FISHERIES ACT, 1883.

TABLE OF CONTENTS.

Preliminary.

1. Short title	Page. 2
----------------------	------------

Confirmation of convention.

2. Confirmation of convention	2
-------------------------------------	---

Fishery regulations.

3. Power to Her Majesty, by orders in council, to make, &c., regulations for execution of act and maintenance of order	2
4. Punishment for violation of Articles 13 to 22 of convention, and for other offenses	2
5. Punishment for violation of Article 23 of convention	3
6. Regulations as to lights for sea-fishing boats	3

Exclusive fishery limits.

7. Regulations as to foreign sea-fishing boats within exclusive fishery limits.	3
---	---

Registry of British sea-fishing boats.

8. Amendment of 31 and 32 Vict., c. 45, ss. 22-26	3
---	---

Miscellaneous.

9. Prohibition of manufacture and sale of instruments for destroying fishing implements	4
10. Provision as to wreck (Article 25 of convention)	4

Enforcement of act.

11. Who are to be British and foreign sea-fishery officers	4
12. Powers of British sea-fishery officers	4
13. Powers of British and foreign sea-fishery officers	5
14. Protection of, and punishment for, obstructing sea-fishery officers	6

Legal proceedings.

15. Compensation for damages caused by offense	6
16. Summary prosecution of offenses and recovery of fines	6
17. Evidence	7
18. Jurisdiction of courts	7
19. Service to be good if made personally or on board ship	7
20. Masters of boats liable to fines imposed	8
21. Application of fines	8
22. Saving of liability and rights	8

Application of act.

	Page.
23. Extension of act by order in council.....	8
24. Application of act to seas between British Islands and France, and continuance of 6 and 7 Vict., c. 79, as to French convention.....	9
25. General application of act	9

Supplemental.

26. Publication of orders in council.....	9
27. Amendment of 31 and 32 Vict., c. 45, s. 18	9
28. Definitions.....	10
29. Commencement of act	10
30. Repeals	10
31. Continuance of act	11
Schedules	11

AN ACT to carry into effect an International Convention concerning the fisheries in the North Sea, and to amend the laws relating to British sea fisheries. [August 2, 1883.]

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the lord's spiritual and temporal, and commons, in this present Parliament assembled, and by the authority of the same, as follows:

Preliminary.

1. This act may be cited as the Sea Fisheries Act, 1883.

Confirmation of convention.

2. The convention set out in the first schedule to this act (referred to in this act as the convention) is hereby confirmed, and the articles thereof shall be of the same force as if they were enacted in the body of this act.

Fishery regulations.

3. It shall be lawful for Her Majesty from time to time, by order in council, to make, alter, and revoke regulations for carrying into execution this act, and the intent and object thereof, and for the maintenance of good order among sea-fishing boats, and the persons belonging thereto, and to impose fines not exceeding £10 for the breach of such regulations.

4. If within the exclusive fishery limits of the British Islands any person, or if outside those limits any person belonging to a British sea-fishing boat, (a) acts in contravention of articles 13 to 22 (both inclusive) of the first schedule to this act, or any of them; or (b) causes injury to any person in any one or more of the following ways, namely, by assaulting any one belonging to another sea-fishing boat, or by causing damage to another sea-fishing boat, or to any property on board thereof, or belonging thereto; or (c) fishes for oysters or has on board

his boat any oyster dredge within any seas and during any time within and during which oyster fishing is prohibited by law, or by any convention, treaty, or arrangement to which this act may be hereafter applied, such person shall be liable, on summary conviction, to a fine not exceeding £50, or, in the discretion of the court, to imprisonment for a term not exceeding three months, with or without hard labor.

5. If within the exclusive fishery limits of the British Islands, any person, or if outside those limits any person belonging to a British sea-fishing boat, (a) uses any instrument for the purpose of damaging or destroying, by cutting or otherwise, any fishing implements belonging to another sea-fishing boat, except in the cases provided for by articles 20 and 21 of the first schedule to this act; or (b) takes on board or has on board such boat any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise, such person shall be liable on summary conviction to a fine not exceeding £50 or in the discretion of the court to imprisonment for a term not exceeding three months, with or without hard labor, and the instrument shall be liable to be forfeited.

6. The regulations respecting lights for the time being in force under the acts relating to merchant shipping shall, so far as they relate to sea-fishing boats, be deemed to be provisions of this act and may be enforced accordingly, and a sea-fishery officer shall for that purpose, in addition to his powers under this act, have the same powers as are given to any officer by the said acts relating to merchant shipping.

Exclusive fishery limits.

7. (1) A foreign sea-fishing boat shall not enter within the exclusive fishery limits of the British Islands, except for purposes recognized by international law, or by any convention, treaty, or arrangement for the time being in force between Her Majesty and any foreign state, or for any lawful purpose.

(2) If a foreign sea-fishing boat enters the exclusive fishery limits of the British Islands, (a) the boat shall return outside of the said limits so soon as the purpose for which it entered has been answered; (b) no person on board the boat shall fish or attempt to fish while the boat remains within the said limits; (c) such regulations as Her Majesty may from time to time prescribe by order in council shall be duly observed.

(3) In the event of any contravention of this section on the part of any foreign sea-fishing boat, or of any person belonging thereto, the master or person for the time being in charge of such boat shall be liable on summary conviction to a fine not exceeding, in the case of the first offense, £10, and in the case of a second or any subsequent offense, £20.

Registry of British sea-fishing boats.

8. (1) Section 22, 23, 24, and 26 of the sea fisheries act, 1868 (which relate to the registry of British sea-fishing boats), shall have effect as

if articles 5 to 12 (both inclusive) of the first schedule to this act were therein referred to in addition to the articles of the first schedule to that act in the said sections mentioned, and as if offenses under this act were offenses in the said sections mentioned; provided that nothing in the said sections shall be deemed to authorize any foreign sea-fishery officer to do anything which he is not, under the first schedule to this act, authorized to do.

(2) Section 176 of the customs consolidation act, 1876, shall not apply to any British sea-fishing boat entered or registered in pursuance of the said sections of the sea fisheries act, 1868.

Miscellaneous.

9. (1) There shall not be manufactured or sold or exposed for sale at any place within the British Islands, any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise.

(2) In the event of any contravention of this section a person guilty thereof shall be liable, on summary conviction, to a fine not exceeding £50, or, in the discretion of the court, to imprisonment for a term not exceeding three months, with or without hard labor, and the instrument shall be liable to be forfeited.

10. The boats and things specified in article 25 of the first schedule to this act shall be deemed to be "wreck" within the meaning of any acts relating to merchant shipping, so however that the provisions of the said article shall be duly observed.

Enforcement of act.

11. (1) The provisions of this act and of any order in council under this act or under the sections of the sea fisheries act, 1868, amended by this act, shall be enforced by sea-fishery officers, either British or foreign.

(2) The following persons shall be British sea-fishery officers; that is to say, every officer of or appointed by the Board of Trade, every commissioned officer of any of Her Majesty's ships on full pay, every officer authorized in that behalf by the admiralty, every British consular officer, every collector and principal officer of customs in any place in the British Islands, and every officer of customs in the British Islands authorized in that behalf by the commissioners of customs, every divisional officer of the coast guard, and every principal officer of a coast-guard station.

(3) The following persons shall be foreign sea-fishery officers; that is to say, the commander of any vessel belonging to the Government of any foreign state bound by the convention, and any officer appointed by a foreign state for the purpose of enforcing the convention, or otherwise recognized by Her Majesty as a sea-fishery officer of a foreign state.

12. For the purpose of enforcing the provisions of this act and of any order in council under this act or under the sea fisheries act, 1868, as

amended by this act, a British sea fishery officer may with respect to any sea-fishing boat within the exclusive limits of the British Islands and with respect to any British sea-fishing boat outside of those limits, exercise the following powers:

(1) He may go on board it.
(2) He may require the owner, master, and crew, or any of them, to produce any certificates of registry, licenses, official logbooks, official papers, articles of agreement, muster rolls, and other documents relating to the boat or to the crew, or to any member thereof, or to any person on board the boat, which are in their respective possession or control on board the boat, and may take copies thereof or of any part thereof.

(3) He may muster the crew of the boat.

(4) He may require the master to appear and give any explanation concerning his boat and her crew, and any person on board his boat, and the said certificates of registry, licenses, official logbooks, official papers, articles of agreement, muster rolls, and other documents, or any of them.

(5) He may examine all sails, lights, small boats, anchors, grapnels, and fishing implements belonging to the boat.

(6) He may seize any instrument serving only or intended to damage or destroy fishing implements, by cutting or otherwise, which is found on board the boat or in the possession of any person belonging to the boat.

(7) He may make any examination or inquiry which he deems necessary to ascertain whether any contravention of the provisions of this act, or of any such order of council as aforesaid has been committed, or to fix the amount of compensation due for any damage done to another sea-fishing boat, or to any person or property on board thereof or belonging thereto, and may administer an oath for such purpose.

(8) In the case of any person who appears to him to have committed any such contravention he may, without summons, warrant, or other process, both take the offender and the boat to which he belongs and the crew thereof to the nearest or most convenient port, and bring him or them before a competent court, and detain him, it, and them in the port until the alleged contravention has been adjudicated upon.

13. For the purpose of carrying into effect the convention, and of exercising and performing the powers and duties thereby vested in and imposed on cruisers and commanders of cruisers, a foreign sea-fishery officer may, with respect to any British sea-fishing boat, and any sea-fishery officer, whether British or foreign, may, with respect to any foreign sea-fishing boat to which this act for the time being applies, exercise any of the powers conferred by this act on British sea-fishery officers: *Provided*, That (a) nothing in this section shall authorize a sea-fishery officer to do anything not authorized by the convention; and (b) the port to which any sea-fishing boat or any person belonging thereto is taken shall, except where the nationality of such boat is not evidenced by official papers, be a port of the state to which such boat belongs.

14. (1) A sea-fishery officer shall be entitled to the same protection in respect of any action or suit brought against him for any act done or omitted to be done in the execution of his duty under this act, as is given to any officer of customs by the customs consolidation act, 1876, or any act amending the same, and (with reference to the seizure or detention of any ship) by any act relating to the registry of British ships.

(2) If any person obstructs any sea-fishery officer in acting under the powers conferred by this act, or refuses or neglects to comply with any requisition or direction lawfully made or given by or to answer any question lawfully asked by any sea-fishery officer in pursuance of this act, such person shall be liable, on summary conviction, to a fine not exceeding £50, or to be imprisoned for a term not exceeding three months, with or without hard labor.

Legal proceedings.

15. (1) Where on the conviction of any person under this act for an offense it appears to the court that any injury to person or property has been caused by the offense, the court may by such conviction adjudge the person convicted to pay in addition to any fine a reasonable sum as compensation for such injury, and such sum may be recovered as a fine under this act, and when recovered shall be paid to the person injured.

(2) Any compensation specified in a document signed in accordance with article 33 of the first schedule to this act, or fixed by a sea-fishery officer in accordance with any submission to arbitration, may be recovered as a simple contract debt, and in England may also be recovered as a civil debt before a court of summary jurisdiction.

(3) In a proceeding against any person for the recovery of such last-mentioned compensation, the formal document referred to in the said article, or an award of a sea-fishery officer in pursuance of a submission to arbitration signed by the person liable to pay such compensation, shall be sufficient evidence that such person is liable to pay the compensation specified in such document or award.

16. (1) Offenses under this act may (save as otherwise provided) be prosecuted, and fines under this act may be recovered in a summary manner; that is to say, (a) in England before a justice or justices, in manner provided by the summary jurisdiction (English) acts; (b) in Scotland in manner provided by the summary jurisdiction (Scotland) acts, 1864 and 1881; (c) in Ireland within the police district of Dublin metropolis in manner provided by the acts regulating the powers and duties of the justices of the peace of such district, or of the police of such district, and elsewhere in Ireland in manner provided by the petty sessions (Ireland) act, 1851, and the acts amending the same; (d) in the Isle of Man, and the islands of Guernsey, Jersey, Alderney, and Sark, respectively, before any court, governor, deputy governor, deemster, jurat, or other magistrate, in the manner in which the like offense and fines are by law prosecuted and recovered, or as near thereto as circumstances admit.

(2) If any person feels aggrieved by any conviction under this act by a court of summary jurisdiction, or by any determination or adjudication of such court with respect to any compensation under this act, he may, where imprisonment is awarded without the option of a fine, or the sum adjudged to be paid exceeds £5, appeal therefrom as follows: (a) In England the appeal should be to quarter sessions in manner provided by the summary jurisdiction (English) acts; (b) in Ireland the appeal should be to the court of quarter sessions in manner directed by the petty sessions (Ireland) act, 1851, and the acts amending the same; (c) in Scotland, the Isle of Man, and the islands of Guernsey, Jersey, Alderney, and Sark, the appeal shall be to the court and in the manner in which appeals from the like convictions and determinations and adjudications are made.

17. (1) Any document drawn up in pursuance of the first schedule to this act shall be admissible in any proceeding, civil or criminal, as evidence of the facts or matters therein stated.

(2) If evidence contained in any such document was taken on oath in the presence of the person charged in such evidence, and such person had an opportunity of cross-examining the person giving such evidence and of making his reply to such evidence, the sea-fishery officer drawing up such document may certify the said facts, or any of them.

(3) Any document or certificate in this section mentioned purporting to be signed by a sea-fishery officer shall be admissible in evidence without proof of such signature, and if purporting to be signed by any other person, shall, if certified by a sea-fishery officer to have been so signed, be deemed, until the contrary is proved, to have been signed by such other persons.

(4) If any person forges the signature of a sea-fishery officer to any such document as above mentioned, or makes use of any such document knowing the signature thereto to be forged, such person shall be liable on summary conviction to imprisonment for a term not exceeding three months with or without hard labor, and on conviction on indictment to be imprisoned with or without hard labor for a term not exceeding two years, and the cost of the prosecution of any such person on indictment may be paid as in cases of felony.

18. For the purpose of giving jurisdiction to courts under this act, a sea-fishing boat shall be deemed to be a ship within the meaning of any act relating to offenses committed on board a ship, and every court shall have the same jurisdiction over a foreign sea-fishing boat within the exclusive fishery limits of the British Islands, and persons belonging thereto, as such court would have if such boat were a British sea-fishing boat.

19. Service of any summons or other matter in any legal proceeding under this act shall be good service if made personally on the person to be served, or at his last place of abode, or if made by leaving such summons for him on board any sea-fishing boat to which he may be

long, with the person being or appearing to be in command or charge of such boat.

20. (1) Where any offense against this act has been committed by some persons belonging to a sea-fishing boat, the master or person for the time being in charge of such boat shall in every case be liable to be deemed guilty of such offense; provided that if he proves that he issued proper orders for the observance, and used due diligence to enforce the observance of this act, and that the offence in question was actually committed by some other person without his connivance, and that the actual offender has been convicted, or that he has taken all practicable means in his power to prosecute such offender (if alive) to conviction, he shall not be liable to any further punishment than payment of compensation for any injury caused by the offense.

(2) Any fine or compensation adjudged under this act may be recovered in the ordinary way, or, if the court think fit so to order, by distress or pouding and sale of the sea-fishing boat to which the offender belongs, and her tackle, apparel, and furniture, and any property on board thereof or belonging thereto, or any part thereof; provided that, where the boat is a foreign sea-fishing boat, the court may order that in lieu of any such distress the boat may be detained in some port in the British Islands for a period not exceeding three months from the date of the conviction, and the boat may be detained accordingly, and in such case shall not be distrained.

21. (1) The court adjudging any fine or forfeiture under this act may, if it think fit, direct the whole or any part thereof to be applied in or towards payment of the expenses of the proceedings; and, subject to such direction, all fines and the proceeds of all forfeitures recovered under this act shall, notwithstanding anything in any act relating to municipal corporations or otherwise, be paid into the exchequer in such manner as the commissioners of the treasury may direct.

(2) Forfeitures may be destroyed, sold, and disposed of as the court adjudging the forfeiture may direct.

22. (1) Nothing in this act shall prevent any person being liable under any other act or otherwise to any indictment, proceeding, punishment, or penalty, other than is provided twice for the same offense.

(2) Nothing in this act, or in any order in council made thereunder, nor any proceedings under such act or order with respect to any matter, shall alter the liability of any person in any action or suit with reference to the same matter, so that person shall be required to pay compensation twice in respect of the same injury.

Application of act.

23. If at any time after the commencement of this act any convention, treaty, or arrangement respecting sea fisheries is made between Her Majesty and any foreign state, it shall be lawful for Her Majesty by order in council to direct that all or any of the provisions of this act

shall, and the same shall accordingly (subject to the exceptions, restrictions, and conditions, if any, in the order mentioned) apply to the said convention, treaty, or arrangement, and have effect in like manner as if the said convention, treaty, or arrangement were set forth in the first schedule to this act, and were part of that schedule and were the convention referred to in this act.

24. If the provisions of this act are applied by order in council to any convention, treaty, or arrangement made in substitution for the convention set forth in the first schedule to the sea fisheries act, 1868, or for the convention and articles set forth in the schedule to the act of the sixth and seventh years of the reign of Her present Majesty, chapter 79, entitled "An act to carry into effect the convention between Her Majesty and the King of the French, concerning the fisheries in the seas between the British Islands and France," that last-mentioned act shall, after the date fixed by the said order for the application of this act, be repealed, but such last-mentioned act shall, until the said date or any earlier date at which the convention set forth in the first schedule to the sea fisheries act, 1868, comes into operation, continue in force so far as regards French sea-fishing boats and persons belonging thereto within the seas to which the said convention and articles set forth in the schedule thereto apply, so far as those seas are outside the exclusive fishery limits of the British Islands, and are not within the North Sea as defined in the first schedule to this act.

25. This act, so far as it applies to foreign sea-fishing boats outside of the exclusive fishery limits of the British Islands, and persons belonging thereto, and to foreign sea-fishery officers, shall apply only within the North Sea as defined by article 4 of the first schedule to this act, or within the seas specified in any convention, treaty, or arrangement to which this act may be applied by order in council made in pursuance of this act, and to the boats and officers of a foreign state bound by the convention in the first schedule to this act or by any convention, treaty, or arrangement to which this act may be applied, but save as aforesaid this act shall apply to the whole of the British Islands as defined by this act, and to the seas surrounding the same, whether within or without the exclusive fishery limits of the British Islands, and the royal courts of Guernsey and Jersey shall register this act in their respective courts.

Supplemental.

26. Orders in council made in pursuance of this act shall be published in the London Gazette, or otherwise published in such manner as the Board of Trade may direct for such sufficient time before they come into force as to prevent inconvenience.

27. The reference in section 18 of the sea fisheries act, 1868, to section 200 of the customs consolidation act, 1853, shall be construed to refer to section 170 of the customs consolidation act, 1876.

28. In this act, the expression "Sea fishing" shall not include fishing for salmon as defined by any act relating to salmon, but save as afore-said, means the fishing for every description both of fish, and shell-fish, found in the seas to which this act applies, and the expression "Sea fisherman" and other expressions relating to sea fishing shall be construed accordingly; the expression "Sea-fishing boat" includes every vessel of whatever size, and in whatever way propelled, which is used by any person in sea fishing, or in carrying on the business of a sea fisherman; the expression "Fishing implement" means any net, line, float, barrel, buoy, or other instrument, engine, or implement used or intended to be used for the purpose of sea fishing; the expression "British Islands" includes the United Kingdom of Great Britain and Ireland, the Isle of Man, the islands of Guernsey, Jersey, Alderney, and Sark, and their dependencies; the expression "Exclusive fishery limits of the British Islands" means that portion of the seas surrounding the British Islands within which Her Majesty's subjects have, by international law, the exclusive right of fishing, and where such portion is defined by the terms of any convention, treaty, or arrangement for the time being in force between Her Majesty and any foreign state, includes, as regards the sea-fishing boats and officers and subjects of that state, the portion so defined; the expression "The admiralty" means the lord high admiral for the time being of the United Kingdom of Great Britain and Ireland, or any two or more of the commissioners for executing the office of lord high admiral of the United Kingdom; the expression "Consular officer" includes consul-general, consul, and vice-consul, and any person for the time being discharging the duties of consul-general, consul, or vice-consul; the expression "Person" includes a body of persons corporate or unincorporate; the expression "Court" includes any tribunal or magistrate exercising jurisdiction under this act.

29. This act shall come into force on such day as may be fixed by a notice in that behalf published in the London Gazette, which day is in this act referred to as the commencement of this act.

30. (1) After the commencement of this act the acts specified in the first part of the second schedule to this act shall be repealed to the extent specified in the third column of that schedule.

(2) After the commencement of this act the acts specified in the second part of the second schedule to this act shall be repealed to the extent specified in the third column of that schedule:

Provided that, until the date hereinafter mentioned at which such repeal takes full effect, the repeal of the enactments specified in the said second part shall, except within the North Sea, as defined by the first schedule to this act, be subject to the following limitations:

(a) The repeal shall not extend to section 12 of the sea fisheries act, 1868 (which section relates to oyster fishing), nor to the recovery of any penalty for a violation of that section.

(b) The repeal shall extend only to officers and boats within the exclusive fishery limits of the British Islands and to British sea-fishing boats when outside the exclusive fishery limits of the British Islands.

(c) The repeal shall not affect the power of French sea-fishery officers and French courts over British sea-fishing boats when outside the exclusive fishery limits of the British Islands, or the power of British and French sea-fishery officers and British courts over French sea-fishing boats brought within the exclusive fishery limits of the British Islands for offenses committed outside those limits.

(d) The repeal shall not alter the power of receiving as evidence any depositions, minutes, and other documents which by the said acts are made receivable as evidence.

(e) If the convention set forth in the first schedule to the sea fisheries act, 1868, comes into operation, then, upon notice thereof being given in the London Gazette, the said enactments shall, subject to the provisions of this section, be in force for the purposes of such convention.

If this act is applied by order in council to French sea-fishery officers and French sea-fishing boats within the seas to which the convention set forth in the first schedule to the sea fisheries act, 1868, applies, the said repeal of the enactments specified in the second part of the second schedule to this act shall take full effect as from the date at which such application of this act takes effect.

(3) The repeal of any enactment by this act shall not affect anything duly done or suffered, or any liability, penalty, forfeiture, or punishment incurred under any enactment hereby repealed, and any legal proceeding or remedy in respect of such liability, penalty, forfeiture, or punishment may be carried on as if this act had not passed.

31. So much of this act as has effect outside of the exclusive fishery limits of the British Islands shall, if the convention ceases to be binding on Her Majesty, cease to apply to the boats and officers of any foreign state bound by the convention, and if the convention ceases to be binding on any foreign state, shall cease to apply to the boats and officers of such state, but subject as aforesaid this act shall continue in force notwithstanding the determination of the convention.

FIRST SCHEDULE.

International convention for the purpose of regulating the police of the fisheries in the North Sea outside territorial waters.

Her Majesty the Queen of the United Kingdom of Great Britain and Ireland; His Majesty the Emperor of Germany, King of Prussia; His Majesty the King of the Belgians; His Majesty the King of Denmark; the President of the French Republic; and His Majesty the King of the Netherlands, having recognized the necessity of regulating the police of the fisheries in the North Sea outside territorial waters, have

resolved to conclude for this purpose a convention, and have named their plenipotentiaries as follows:—

Her Majesty the Queen of the United Kingdom of Great Britain and Ireland: the Hon. William Stuart, Companion of the Most Honorable Order of the Bath, &c., her envoy extraordinary and minister plenipotentiary at the Hague; Charles Malcolm Kennedy, esq., Companion of the Most Honorable Order of the Bath, &c., head of the commercial department of the foreign office; and Charles Cecil Trevor, esq., barrister at law, assistant secretary to the Board of Trade, &c.;

His Majesty the Emperor of Germany, King of Prussia: Veit Richard von Schmidthals, Knight of the Order of the Red Eagle of the third class, and of the Order of St. John, &c., councilor of legation, his chargé d'affaires at the Hague; and Peter Christian Kinch Donner, Knight of the Order of the Red Eagle of the fourth class with the Sword, and of the Crown of the fourth class, &c., his councilor of state, captain in the navy, on the reserve;

His Majesty the King of the Belgians: the Baron d'Anethan, Commander of the Order of Leopold, &c., his envoy extraordinary and minister plenipotentiary at the Hague; and M. Léopold Orban, Commander of the Order of Leopold, &c., his envoy extraordinary and minister plenipotentiary, director-general of the political department in the ministry of foreign affairs;

His Majesty the King of Denmark: Carl Adolph Bruun, Knight of the Order of the Danebrog, &c., captain in the navy;

The President of the French Republic: the Count Lefèbvre de Béhaine, Commander of the National Order of the Legion of Honor, &c., envoy extraordinary and minister plenipotentiary of the French Republic at the Hague; and M. Gustave Émile Mancel, Officer of the National Order of the Legion of Honor, &c., commissary of marine;

His Majesty the King of the Netherlands: the Jonkheer Willem Frederik Rochussen, Commander of the Order of the Lion of the Netherlands, &c., his minister of foreign affairs; and Eduard Nicolaas Rahusen, Knight of the Order of the Lion of the Netherlands, &c., president of the committee for sea fisheries;

Who, after having communicated the one to the other their full powers, found in good and due form, have agreed upon the following articles:—

ARTICLE I.

The provisions of the present convention, the object of which is to regulate the police of the fisheries in the North Sea outside territorial waters, shall apply to the subjects of the high contracting parties.

ARTICLE II.

The fishermen of each country shall enjoy the exclusive right of fishery within the distance of 3 miles from low-water mark along the

whole extent of the coast of their respective countries, as well as of the dependent islands and banks.

As regards bays, the distance of 3 miles shall be measured from a straight line drawn across the bay, in the part nearest the entrance, at the first point where the width does not exceed 10 miles.

The present article shall not in any way prejudice the freedom of navigation and anchorage in territorial waters accorded to fishing boats, provided they conform to the special police regulations enacted by the powers to whom the shore belongs.

ARTICLE III.

The miles mentioned in the preceding article are geographical miles, whereof sixty make a degree of latitude.

ARTICLE IV.

For the purpose of applying the provisions of the present convention, the limits of the North Sea shall be fixed as follows:

1. On the north by the parallel of the 61st degree of latitude.
2. On the east and south (1) by the coasts of Norway between the parallel of the 61st degree of latitude and Lindesnaes Light-house (Norway); (2) by a straight line drawn from Lindesnaes Light-house (Norway) to Hanstholm Light-house (Denmark); (3) by the coasts of Denmark, Germany, the Netherlands, Belgium, and France as far as Gris Nez Light-house.
3. On the west, (1) by a straight line drawn from Gris Nez Light-house (France) to the easternmost light-house at South Foreland (England); (2) by the eastern coasts of England and Scotland; (3) by a straight line joining Duncansby Head (Scotland) and the southern point of South Ronaldsha (Orkney Islands); (4) by the eastern coasts of the Orkney Islands; (5) by a straight line joining North Ronaldsha Light-house (Orkney Islands) and Sumburgh Head Light-house (Shetland Islands); (6) by the eastern coasts of the Shetland Islands; (7) by the meridian of North Unst Light-house (Shetland Islands) as far as the parallel of the 61st degree of latitude.

ARTICLE V.

The fishing boats of the high contracting parties shall be registered in accordance with the administrative regulations of each country. For each port there shall be a consecutive series of numbers, preceded by one or more initial letters, which shall be specified by the superior competent authority.

Each Government shall draw up a list showing these initial letters. This list, together with all modifications which may subsequently be made in it, shall be notified to the other contracting powers.

ARTICLE VI.

Fishing boats shall bear the initial letter or letters of the port to which they belong and the registry number in the series of numbers for that port.

ARTICLE VII.

The name of each fishing boat and that of the port to which she belongs shall be painted in white oil color on a black ground on the stern of the boat, in letters which shall be at least 8 centimeters in height and 12 millimeters in breadth.

ARTICLE VIII.

The letter or letters and numbers shall be placed on each bow of the boat 8 or 10 centimeters below the gunwale, and so as to be clearly visible. They shall be painted in white oil color on a black ground.

The distance above mentioned shall not, however, be obligatory for boats of small burden, which may not have sufficient space below the gunwale.

For boats of 15 tons burden and upwards the dimensions of the letters and numbers shall be 45 centimeters in height and 6 centimeters in breadth.

For boats of less than 15 tons burden the dimensions shall be 25 centimeters in height and 4 centimeters in breadth.

The same letter or letters and numbers shall also be painted on each side of the mainsail of the boat, immediately above the close reef, in black oil color on white or tanned sails, and in white oil color on black sails.

The letter or letters and numbers on the said sails shall be one-third larger in every way than those placed on the bows of the boat.

ARTICLE IX.

Fishing boats may not have, either on their outside or on their sails, any names, letters, or numbers other than those prescribed by Articles VI, VII, and VIII of the present convention.

ARTICLE X.

The names, letters, and numbers placed on the boats and on their sails shall not be effaced, altered, made illegible, covered, or concealed in any manner whatsoever.

ARTICLE XI.

All the small boats, buoys, principal floats, trawls, grapnels, anchors, and generally all fishing implements shall be marked with the letter or letters and numbers of the boats to which they belong.

These letters and numbers shall be large enough to be easily distinguished. The owners of the nets or other fishing implements may further distinguish them by any private marks they think proper.

ARTICLE XII.

The master of each boat must have with him an official document, issued by the proper authority in his own country, for the purpose of enabling him to establish the nationality of the boat.

This document must always give the letter or letters and number of the boat, as well as her description and the name or names of the owner or the name of the firm or association to which she belongs.

ARTICLE XIII.

The nationality of a boat must not be concealed in any manner whatsoever.

ARTICLE XIV.

No fishing boat shall anchor between sunset and sunrise on grounds where drift-net fishing is actually going on.

This prohibition shall not, however, apply to anchorings which may take place in consequence of accidents or of any other compulsory circumstances.

ARTICLE XV.

Boats arriving on the fishing-grounds shall not either place themselves or shoot their nets in such a way as to injure each other, or as to interfere with fishermen who have already commenced their operations.

ARTICLE XVI.

Whenever, with the view of drift-net fishing, decked boats and undecked boats commence shooting their nets at the same time, the undecked boats shall shoot their nets to windward of the decked boats.

The decked boats, on their part, shall shoot their nets to leeward of the undecked boats.

As a rule, if decked boats shoot their nets to windward of undecked boats which have begun fishing, or if undecked boats shoot their nets to leeward of decked boats which have begun fishing, the responsibility as regards any damages to nets which may result shall rest with the boats which last began fishing, unless they can prove that they were under stress of compulsory circumstances or that the damage was not caused by their fault.

ARTICLE XVII.

No net or any other fishing engine shall be set or anchored on grounds where drift-net fishing is actually going on.

ARTICLE XVIII.

No fisherman shall make fast or hold on his boat to the nets, buoys, floats, or any other part of the fishing-tackle of another fisherman.

ARTICLE XIX.

When trawl fishermen are in sight of drift-net or of long-line fishermen, they shall take all necessary steps in order to avoid doing injury to the latter. Where damage is caused, the responsibility shall lie on the trawlers, unless they can prove that they were under stress of compulsory circumstances, or that the loss sustained did not result from their fault.

ARTICLE XX.

When nets belonging to different fishermen get foul of each other the nets shall not be cut without the consent of both parties.

All responsibility shall cease if the impossibility of disengaging the nets by any other means is proved.

ARTICLE XXI.

When a boat fishing with long lines entangles her lines in those of another boat, the person who hauls up the lines shall not cut them except under stress of compulsory circumstances, in which case any line which may be cut shall be immediately joined together again.

ARTICLE XXII.

Except in cases of salvage and the cases to which the two preceding articles relate, no fisherman shall, under any pretext whatever, cut, hook, or lift up nets, lines, or other gear not belonging to him.

ARTICLE XXIII.

The use of any instrument or engine which serves only to cut or destroy nets is forbidden.

The presence of any such engine on board a boat is also forbidden.

The high contracting parties engage to take the necessary measures for preventing the embarkation of such engines on board fishing boats.

ARTICLE XXIV.

Fishing boats shall conform to the general rules respecting lights which have been or may be adopted by mutual arrangement between the high contracting parties with the view of preventing collisions at sea.

ARTICLE XXV.

All fishing boats, all their small boats, all rigging gear or other appurtenances of fishing boats, all nets, lines, buoys, floats, or other fishing implements whatsoever found or picked up at sea, whether marked

or unmarked, shall as soon as possible be delivered to the competent authority of the first port to which the salvaging boat returns or puts in.

Such authority shall inform the consul or consular agent of the country to which the boat of the salvor belongs, and of the nation of the owner of the articles found. They (the same authority) shall restore the articles to the owners thereof or to their representatives as soon as such articles are claimed and the interests of the salvors have been properly guaranteed.

The administrative or judicial authorities, according as the laws of the different countries may provide, shall fix the amount which the owners shall pay to the salvors.

It is, however, agreed that this provision shall not in any way prejudice such conventions respecting this matter as are already in force, and that the high contracting parties reserve the right of regulating, by special arrangements between themselves, the amount of salvage at a fixed rate per net salvaged.

Fishing implements of any kind found unmarked shall be treated as wreck.

ARTICLE XXVI.

The superintendence of the fisheries shall be exercised by vessels belonging to the national navies of the high contracting parties. In the case of Belgium, such vessels may be vessels belonging to the state, commanded by captains who hold commissions.

ARTICLE XXVII.

The execution of the regulations respecting the document establishing nationality, the marking and numbering of boats, &c., and of fishing implements, as well as the presence on board of instruments which are forbidden (Articles VI, VII, VIII, IX, X, XI, XII, XIII, and XXIII, section 2), is placed under the exclusive superintendence of the cruisers of the nation of each fishing boat.

Nevertheless, the commanders of cruisers shall acquaint each other with any infractions of the above-mentioned regulations committed by the fishermen of another nation.

ARTICLE XXVIII.

The cruisers of all the high contracting parties shall be competent to authenticate all infractions of the regulations prescribed by the present convention, other than those referred to in Article XXVII, and all offenses relating to fishing operations, whichever may be the nation to which the fishermen guilty of such infractions may belong.

ARTICLE XXIX.

When the commanders of cruisers have reason to believe that an infraction of the provisions of the present convention has been committed,

they may require the master of the boat inculpated to exhibit the official document establishing her nationality. The fact of such document having been exhibited shall then be indorsed upon it immediately.

The commanders of cruisers shall not pursue further their visit or search on board a fishing boat which is not of their own nationality, unless it should be necessary for the purpose of obtaining proof of an offense or of a contravention of regulations respecting the police of the fisheries.

ARTICLE XXX.

The commanders of the cruisers of the signatory powers shall exercise their judgment as to the gravity of facts brought to their knowledge, and of which they are empowered to take cognizance, and shall verify the damage, from whatever cause arising, which may be sustained by fishing boats of the nationalities of the high contracting parties.

They shall draw up, if there is occasion for it, a formal statement of the verification of the facts as elicited both from the declarations of the parties interested and from the testimony of those present.

The commander of the cruiser may, if the case appears to him sufficiently serious to justify the step, take the offending boat into a port of the nation to which the fishermen belong. He may even take on board the cruiser a part of the crew of the fishing boat, in order to hand them over to the authorities of her nation.

ARTICLE XXXI.

The formal statement referred to in the preceding article shall be drawn up in the language of the commander of the cruiser, and according to the forms in use in his country.

The accused and the witnesses shall be entitled to add, or to have added, to such statement, in their own language, any observations or evidence which they may think suitable. Such declarations must be duly signed.

ARTICLE XXXII.

Resistance to the directions of commanders of cruisers charged with the police of the fisheries, or of those who act under their orders, shall, without taking into account the nationality of the cruiser, be considered as resistance to the authority of the nation of the fishing boat.

ARTICLE XXXIII.

When the act alleged is not of a serious character, but has nevertheless caused damage to any fisherman, the commanders of cruisers shall be at liberty, should the parties concerned agree to it, to arbitrate at sea between them, and to fix the compensation to be paid.

Where one of the parties is not in a position to settle the matter at once, the commanders shall cause the parties concerned to sign in duplicate a formal document specifying the compensation to be paid.

One copy of this document shall remain on board the cruiser, and the other shall be handed to the master of the boat to which the compensation is due, in order that he may, if necessary, be able to make use of it before the courts of the country to which the debtor belongs.

Where, on the contrary, the parties do not consent to arbitration, the commanders shall act in accordance with the provisions of Article XXX.

ARTICLE XXXIV.

The prosecutions for offenses against or contraventions of the present convention shall be instituted by or in the name of the state.

ARTICLE XXXV.

The high contracting parties engage to propose to their respective legislatures the necessary measures for insuring the execution of the present convention, and particularly for the punishment by either fine or imprisonment, or by both, of persons who may contravene the provisions of Articles VI to XXIII, inclusive.

ARTICLE XXXVI.

In all cases of assault committed or of wilful damage or loss inflicted by fishermen of one of the contracting countries upon fishermen of another nationality, the courts of the country to which the boats of the offenders belong shall be empowered to try them.

The same rule shall apply with regard to offenses against and contraventions of the present convention.

ARTICLE XXXVII.

The proceedings and trial in cases of infraction of the provisions of the present convention shall take place as summarily as the laws and regulations in force will permit.

ARTICLE XXXVIII.

The present convention shall be ratified. The ratifications shall be exchanged at the Hague as soon as possible.

ARTICLE XXXIX.

The present convention shall be brought into force from and after a day to be agreed upon by the high contracting parties.

The convention shall continue in operation for five years from the above day; and, unless one of the high contracting parties shall, twelve months before the expiration of the said period of five years, give notice of intention to terminate its operation, shall continue in force one year longer, and so on from year to year. If, however, one of the signatory powers should give notice to terminate the convention, the same shall be maintained between the other contracting parties, unless they give a similar notice.

ADDITIONAL ARTICLE.

The Government of His Majesty the King of Sweden and Norway may adhere to the present convention, for Sweden and for Norway, either jointly or separately.

This adhesion shall be notified to the Netherlands Government, and by it to the other signatory powers.

In witness whereof the plenipotentiaries have signed the present convention, and have affixed thereto their seals.

Done at the Hague, in six copies, the 6th May, 1882.

W. STUART.

LÉOPOLD ORBAN.

C. M. KENNEDY.

C. BRUUN.

C. CECIL TREVOR.

C^{te} LEFÈVRE DE BÉHAINE.

V. SCHMIDTHALS.

EM. MANCER.

CHR. DONNER.

ROCHUSSEN.

B^{on} A. D'ANETHAN.

E. N. RAHUSEN.

SECOND SCHEDULE.

ENACTMENTS REPEALED.

A description or citation of an act in this schedule is inclusive of the word, section, or other part first and last mentioned, or otherwise referred to as forming the beginning or as forming the end of the portion described in the description or citation.

PART I.—*Enactments wholly repealed.*

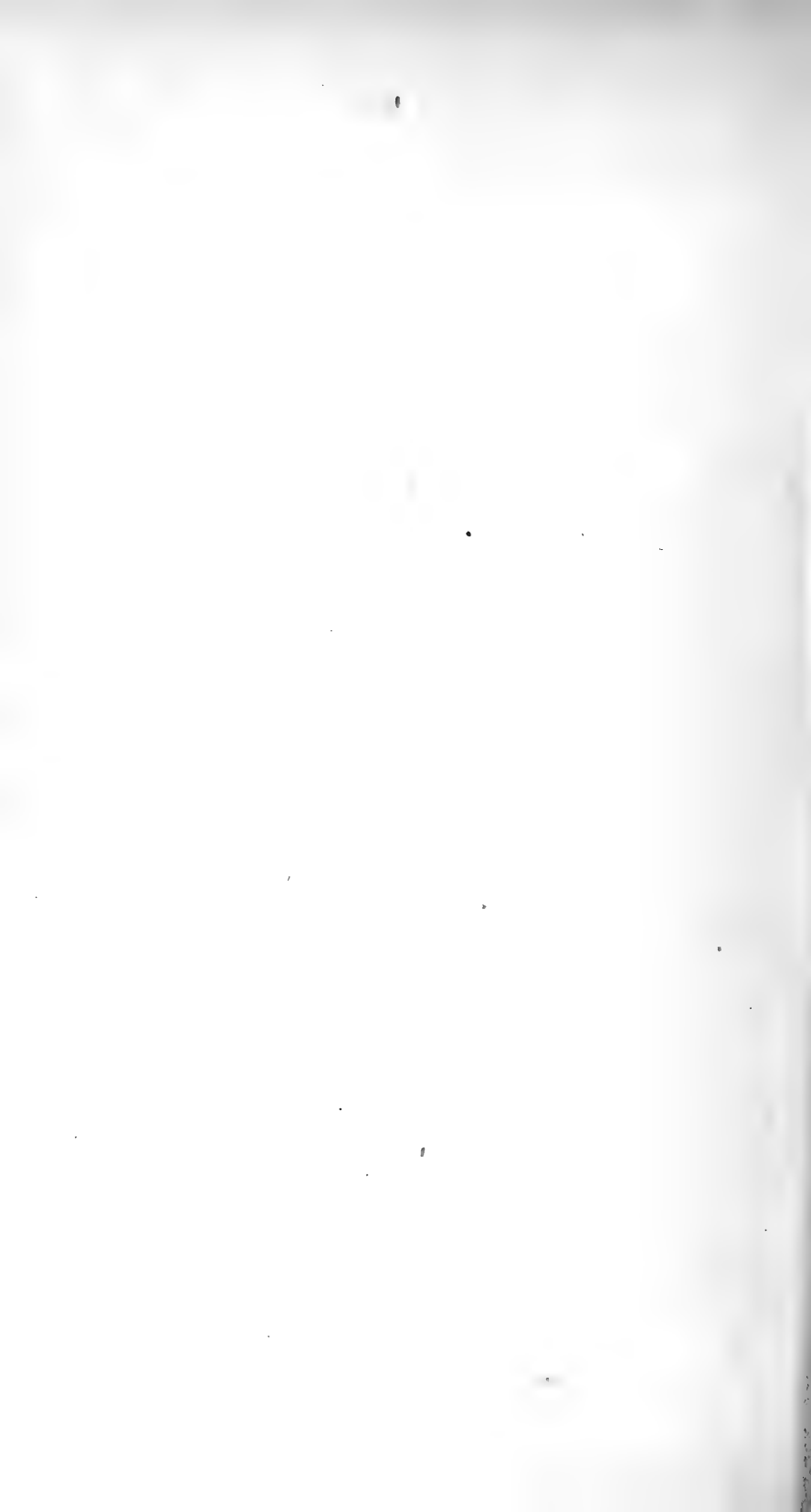
Session and chapter.	Title.	Extent of repeal.
6 and 7 Vict., c. 79.	An act to carry into effect a convention between Her Majesty and the King of the French concerning the fisheries in the seas between the British Islands and France.	So much of the schedule thereto as prohibits any French fishing-boat from approaching nearer to any part of the coast of the United Kingdom than the limit of 3 miles, and so much of the rest of the act as relates to the portion of the schedule hereby repealed.
31 and 32 Vict., c. 45.	The sea fisheries act, 1868.	Section 25; Section 58, from "in manner directed by law" to "the appeal shall be made," and from "for the county or place" to "costs to be paid by either party"; Section 71 and the second schedule.
40 and 41 Vict., c. 42.	The fisheries (oyster, crab, and lobster) act, 1877.	Section 15.

PART II.—*Enactments repealed provisionally.*

31 and 32 Vict., c. 45.	The sea fisheries act, 1868.	Sections 3 and 4; Section 5, from "the term consular officer" to "construed to mean consular officer"; Section 6 to 16; Sections 20 and 21; Section 59; Section 61; Section 63, from the beginning of the section to "the satisfaction of the court"; The first schedule, except articles 4 to 8, article 31, and the declaration and list of ports annexed to the convention.
38 Vict., c. 15.	An act to amend the sea fisheries act, 1868.	Section 3.

APPENDIX B.

THE FISHERIES.



V.—THE PRINCIPAL RIVER FISHERIES OF THE UNITED STATES, WITH AN ESTIMATE OF THE CATCH FOR 1880.

BY CHAS. W. SMILEY.

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
MAINE.		MASSACHUSETTS—Continued.	
	<i>Pounds.</i>		<i>Pounds.</i>
Saint John River	20,000	Parker and Ipswich Rivers, and Wenham Pond	8,000
Saint Croix River, Schoodic Lake and tributaries	45,000	Essex River, Chebacco Pond, North, South, and Saugus Rivers	100,000
Denny's River	50,000	Mystic, Charles, and Neponset Rivers	175,000
Cobscook River	25,000	Fore, Back, North, South, and Jones Rivers	220,000
Machias and East Machias Rivers	125,000	Great South Pond	50,000
Tunk, Narragangus, Harrington, Pleasant, Indian, and Chandler's Rivers	135,000	Streams, &c., of Barnstable and Dukes Counties	800,000
Union River	25,000	Wareham and Half-way Ponds, We-wauntitt, Mattapoisett, Sippican, Acushnet, Apponegansett, Paman-set, and Westport Rivers	875,000
Penobscot River: Gray's or Walker's Pond, Alamoosook, Toddy, Craig, and other ponds, Pushaw River, Passadumkeag River, Piscataquis, Pleasant, Sebec River and ponds, Mattawamkeag and Salmon Rivers	700,000	Taunton River: Nomasket River and Winetuxet River	860,000
Pemaquid, Muscongus, Saint George Rivers, &c.	450,000	Palmer River	10,000
Damariscotta River	1,500,000	RHODE ISLAND.	
Sheepscott River	50,000	Wallum Lake	3,000
Kennebec River: Androscoggin River, Little Androscoggin River and Thompson Lake, Weld Pond, Ellis and Bear Branch, Umbagog, Richardson, Molechunkemunk River, Moostocmaguntic, Rangeley, and other lakes, Eastern River, Cob-bossecontee River and Lake, Se-bastickcook River, Messalonskee River and Belgrade Lake, Wisse-runset, Sandy, Carrabasset, and Dead Rivers, Moosehead Lake, Moose River	1,290,000	Sakonnet River	450,000
Presumpscot River: Sebago, Long Lake, &c., Songo River, Crooked River	18,000	Warren River	40,000
Saco River, Little Ossipee River	16,500	Providence River: Pawtucket River, Blackstone River	353,000
Mousam River	10,000	Powtowomut and Pawtuxet Rivers	55,000
York River	5,000	Coast ponds and Pettaquamsutt River	65,000
Piscataquis River	85,000	Pawcatuck River	45,000
VERMONT.		CONNECTICUT.	
Lake Memphremagog, Black River, and Barton River	65,500	Mystic River	9,000
Lake Champlain: Lamaille River, Winooski or Onion River, Otter Creek, Poultney River, Pawlet River, Lake George, Boquet River, Au Sable River, Chazy River, Sar-anac River and Lake	1,272,000	Thames River: Quinebaugh River, Shetucket River, Moosup River	29,500
MASSACHUSETTS.		Connecticut River: Farmington River, Agawam, Little, and West-field Rivers; Chicopee, Ware, and Swift Rivers; Deerfield and Miller's Rivers; Ashuelot River, West River, Sugar River, Ammonoosuc River, and Indian Stream	842,300
Merrimac River: Concord, Sudbury, and Assabet Rivers, Nashua River, Contoocook River, Pemigewasset River, Winnipiseogee Lake and River	400,000	Branford River	150
		Quinnipiac River	2,500
		Housatonic River: Naugatuck River, Shepaug River	230,000
		Saugatuck River	1,500
		Norwalk River	6,000
		Mianus and Mill Rivers	250
		NEW YORK.	
		Hudson River: Croton River and Lake, Dutchess and Columbia County streams and lakes, Rond-out and Walkill Rivers, Esopus Creek, Catskill Creek, Kinderhook Creek and Lake, Mohawk River, Schoharie River, West Canada	

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
NEW YORK—Continued.	Pounds.	MARYLAND—Continued.	Pounds.
Hudson River—Continued.		Choptank River	1,000,000
Creek, Fish Creek and Saratoga Lake, Battenkill Creek and Lake, Sacandaga River, Schroon River and Lake, Indian River and Lake, Jessup's, Boreas and Cedar Rivers, Delia and Sanford Lakes	3,300,000	Broad and Harris Creeks	10,000
Saint Lawrence River: Chateaugay River and Lake, Trout and Salmon Rivers, Saint Regis, Racket, and Grass Rivers, Oswegatchie River, Black Lake, Cranberry Lake	1,100,000	Wye and Saint Michael's Rivers	20,000
Greenwood, Rockland, Cedar, and other Lakes	45,000	Chester River	50,000
Byram River	3,000	Sassafras River	45,000
Long Island streams and ponds	210,000	Elk River	50,000
The canals	30,000	Northeast River	75,000
Princess Bay		Susquehanna River: Big and Little Conewago Creeks, Conestoga, Calico, and Chieques Creek, Conodoguinet and Sherman Creeks, Juniata River, Raystown Creek, Middle and Penn's Creeks, and Gravel Run, Muncy, Loyalsock, Lycoming, Pine, and Babb's Creeks, Fishing, Bald Eagle, and Beech Creeks, Sinnemahoning River, Young Woman, Paddy, Kettie, East Branch, and Portage Creeks, Moshannon, Clearfield, and Chest Creeks, Columbia, Luzerne, and Lackawanna County tributaries, Harvey's Lake, Mekoopany, Tunkhannock, Martin, Hop Bottom, and Meshoppen Creeks, and Carey's, Oxbow, and Elk Lakes, Towanda, and Sugar Creeks, Chemung River, Tioga, Canisteo, and Conchocton Rivers, Lamoka and Oneta (Wauneta) Lakes, Cayuta Creek, Chenango River, Tioughnioga and Otsetic Rivers, Unadilla River, Otsego and Charlotte Creeks, Otsego, and Schnyler's (Canaderaga) Lakes	2,000,000
NEW JERSEY.		Bush River	50,000
Hopatcong, Budd's, Green, Split, Rock Lakes, &c.	140,000	Gunpowder River	100,000
Hackensack River	250,000	Middle and Back Rivers	50,000
Passaic River	125,000	Patapsco River	200,000
Raritan River, South River, Neshanic River	285,000	Magothy River	25,000
Shrewsbury River	350,000	Severn River	25,000
Shark River	80,000	South River	10,000
Barneget Bay: Tonis and Metedeconk Rivers	300,000	Rhode River	5,000
Mullicus, or Little Egg Harbor River, Bass, and Wading Rivers	345,000	West River	10,000
Great Egg Harbor River	120,000	Patuxent River	800,000
Tuckahoe River	45,000	Potomac River: Wicomico River, Monocacy River, rivers and creeks of Northumberland and Westmoreland Counties, Aquia, Chopawamsic, and Quantico Creeks, Occoquan River, Goose Creek, Shenandoah River, Cedar Creek, South, Christians, and Middle Forks, Opequon Creek, Conococheague, Licking, Conotowas, Town, and Wills Creeks	6,000,000
West, East, and Dennis Creeks	95,000		
Maurice River; Lebanon and Muddy Creeks	290,000		
Delaware River: Cohansey Creek, Stow, Alloways, Salem, Old Man's, Mantua, Cooper, and Crosswicks Creeks, Rancocas Creek, Musconetcong, Pequest, Paulinskill Rivers, and Schwartzwood Lake, Christiana Creek, Brandywine Creek, Schuylkill River, Neshaminy Creek, Great and Little Lehigh Rivers, Hockendauga Creek, Lackawaxen River, Walen Panpac Creek, Long, Keene, Elk, White Oak, Maple, and other ponds, Neversink, Beaverkill Rivers, Ponds, &c	8,525,000		
DELAWARE.		VIRGINIA.	
Mahon River	7,000	Rappahannock River, Rapidan River	1,500,000
Saint Jones Creek	729,000	Piankatank River	350,000
Murderkill Creek	32,000	East, North, Ware, and Severn Rivers	250,000
Misphillion and Cedar Creeks	110,000	York River: Mattaponi River, Pamunkey River, North and South Anna Rivers	1,800,000
Broad Kill Creek	22,000	Back River	270,000
Indian River	310,000	James River: Hampton, Elizabeth, and Nausemond Rivers, and Pagan Creek, Chickahominy River, Appomattox River, Willis, Rivanna, Slate, and Hardware Rivers, North River, Catawba and Craig Creeks, Cow Pasture and Jackson Rivers	3,750,000
Creeks in Accomac and Northampton Counties of Virginia	950,000	Lynhaven River	200,000
MARYLAND.*		Lake Drummond	10,000
Pocomoke, Annesmessex, Manokin, and Wicomico Rivers	650,000		
Nanticoke River	400,000		
Blackwater and Transquaking Rivers	15,000		
Houga River	5,000		
Little Choptank River	5,000		

* This is the State where the waters of the streams named under it reach the ocean, though the streams themselves may flow through other States.

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
NORTH CAROLINA.		FLORIDA—Continued.	
	Pounds.		Pounds.
North River.....	65, 000	Charlotte Harbor, Pease Creek.....	25, 000
Pasquotank River.....		Sarasota Bay.....	10, 000
Perquimans River.....		Tampa Bay, Manatee River, Hills-	
Chowan River, Meherrin, Nottaway,		boro Bay and River, Alafia River.....	15, 000
and Blackwater Rivers.....	375, 000	Boca Diego Bay.....	5, 000
Roanoke River: Cashie River, Staun-		Clear Water Harbor.....	5, 000
ton River, Otto, and Blackwater		Anclote and Echaskotee Rivers.....	20, 000
Rivers, Dan River, Hycottlee, Ban-		Chesschowiska and Homosassa Riv-	
ister, and Smiths Rivers.....	560, 000	ers.....	10, 000
Suppermong River.....		Crystal River.....	5, 000
Pamlico River, Pungo River.....	490, 000	Withlococoochee River.....	20, 000
Bay River.....	35, 000	Wacassassa River.....	15, 000
Neuse River, Trent River, Content-		Suwannee River: Santa Fe River,	
nea Creek, Eno, Little and Flat		Sampson and Butler Lakes, Pith-	
Rivers.....	350, 000	lacoochee, Santa Fé, and other	
Newport River.....	225, 000	lakes, Allapaha River, Withcaco-	
White Oak River.....	2, 220, 000	chee and Little Rivers, Pisacola,	
New River.....	700, 000	Ocopilco, Ty Ty, and Warrior	
Cape Fear River: Northeast Cape		Creeks.....	100, 000
Fear River, South River, Black		Steinhatchee River.....	5, 000
River, Upper and Lower Little		Ocilla and Wacissa Rivers.....	10, 000
Rivers, Deep River, Haw River.....	1, 289, 300	Saint Mark's River and Micoosukee	
Logwood Folly River.....	40, 000	Lake.....	25, 000
		Ocklockonee River.....	25, 000
SOUTH CAROLINA.		Apalachicola River: Chipola River,	
		Chattahoochee River, Flint River,	
Winyah Bay: Waccamaw River,		Natchaway and Pachitta Creeks,	
Waccamaw Lake, Great Pee Dee		Kinahafonee, Muckhall, Buck,	
River, Little Pee Dee River, Lum-		Cedar, Camp, and White Oak	
ber River, Lynche's Creek,		Creeks, Osahatchee, Big Dover,	
Crooked Creek, Iredell and Yadkin		Sugar, Tespatee, and Chestatee	
Counties (N. C.) creeks and ponds,		Creeks.....	300, 000
Black River.....	820, 000	Saint Andrew's Bay.....	5, 000
Santee River: Wateree River, (Ca-		Choctawhatchee River, Pea River.....	20, 000
tawba, in North Carolina), John's		Yellow and Blackwater Rivers.....	20, 000
River, Congaree River, Saluda		Escambia River, Conecuh River.....	20, 000
River, Broad River, Enoree, and		Perdido Bay and River.....	5, 000
Tiger Rivers.....	452, 500		
Ashley and Cooper Rivers.....	25, 000	ALABAMA.	
Edisto River, Four-Hole Creek.....	267, 500	Bon Secour, Fish, and Tensaw	
Ashepoo River.....	50, 000	Rivers.....	165, 000
Combahee River.....	25, 000	Mobile River: Lesser tributaries of	
Coosawhatchie River.....	450, 000	the Mobile River, Tombigbee	
Savannah River: Briar and McBean		River, Sucarnocnee and Alamu-	
Creeks, Horse and Big Spencer		chie Rivers, Tuscaloosa River, Coal	
Creeks, and Langley and other		Fire and Sipsey Rivers, Buttahat-	
mill ponds, Tugaloo River, Broad		chee, Looxapahla, Noxubee, and	
River, Tallulah and Chatuga		Tibbee Rivers, Alabama River,	
Rivers, Keowee River.....	1, 072, 500	Cahawba River, Coosa River, Hat-	
		chett, Paint, Peckerwood, Kelley,	
GEORGIA.		Wolf, Tallasseehatchee, Yellow	
Ogeechee River, Cannouchee River.....	400, 000	Leaf and Talladega Creeks, Cheek-	
North and South Newport and Sapelo		elecke, Shoal, Cane, and Tallasee	
Rivers.....	375, 000	Creeks, Ohatchie, Wills, Chatoga,	
Altamaha River: Great Oohopee		Cedar, and Little Creeks, Etowah	
River, Oconee River, Turkey, Ap-		River, Coosawattee River, Conna-	
palachee and Mulberry Creeks, Oc-		sauqua and Coahulla Rivers, Elli-	
mulgee River, Swamp and Sugar		jay and Carticay Rivers, Talla-	
Creeks, South and Yellow Rivers,		poosa River.....	1, 418, 000
Alcora, Willow and Murder		Bayou la Batre.....	85, 000
Creeks.....	500, 000		
Great and Little Satilla Rivers.....	380, 000	MISSISSIPPI AND LOUISIANA.	
Saint Mary's River.....	275, 000	Pascagoula River: Leaf River, Bogue	
FLORIDA.		Homo and Tallahala Creek, Oka-	
		toma and Oakohay Creeks, Chick-	
Saint John's River: Lake Crescent		asawha River.....	365, 000
and Deep River, Ocklawaha River,		Old Forte Bayou.....	10, 000
Orange River and Lake, Lake Grif-		Biloxi River.....	12, 000
fin, Lake Eustis, Lake Ocklawaha,		Wolf River.....	10, 000
Lake Apopka, Lake Kingsley,		Pearl River: Bogue Chitto, Silver	
Lake George, Lake Monroe, Lake		Creek, Strong River, Yockanock-	
Jessup, Lakes Weekiva, Maitland,		any River.....	310, 000
Norris, and Yale, Lake Conway,		Lakes Ponchartrain and Bogue,	
Lake Pointsett.....	500, 000	Lake Maurepas, Amite River, Tan-	
Matanzas River.....	5, 000	gipohoa River.....	1, 115, 000
Halifax and Hillsboro Rivers.....	10, 000	Little Lake and River Aux Chenes.....	5, 000
Indian River.....	50, 000	Bayous and bays near New Orleans.....	95, 000
Caloosahatchie River.....	15, 000		

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
MISSISSIPPI RIVER SYSTEM.	<i>Pounds.</i>	MISS. RIVER SYSTEM—Cont'd.	<i>Pounds.</i>
Red River (tributary of Mississippi River): Black or Washita River, Tensas River, Bayou Bartholomew, Bayou d'Arbonne, Saline River, Eagle Creek, Bayous Moro and Champagnolle, Little Missouri River, Caddo Creek, Badeau and Dorchest Bayous, Caddo Lake, Little and Big Cypress Rivers, Sulphur Fork, Little and Saline Rivers, Boggy River, Blue River, Little Wichita and Big Wichita Rivers. . .	2, 020, 000	Ohio River—Continued. Stone River, Caney Fork, Obey's River, Narrowbone, Crocus, Beaver, and Otter Rivers, New and Clear Fork, Rockcastle River, Tradewater River, Saline River, Wabash River, Little Wabash River, Skillet Fork, Patoka River, White River, East Fork of White River, Lost Creek, Indian and Salt Creeks, Muscatatuck and Graham Creeks, Sand Creek, Big and Little Flat Rock, Haw, Clifty, and Sugar Creeks and Blue River, West Fork of White River, Eel River, Deer Creek, Bean, Blossom, White Lick, Eagle, and Fall Creeks, Embarras River, Sugar and Brullet Creeks, and Vermillion River, Raccoon, Sugar, and Coal Creeks, Pine Creek, Wild Cat Creek, Tippecanoe River, Manitau, Pike, and other lakes, Mud Creek, Eel River, Mississineau and Salamonias Rivers, Green River, Pond River, Rough and Caney Creeks, Muddy and Clifty Rivers, Barren River, Casper River, Beaver Creek, Drakes Fork, Rays Fork, Nolin Creek, Little Barren River, Russell's Creek, Otter Creek, Little Pigeon, Anderson's and Indian Creeks, and Little and Great Blue Rivers, Salt River, Rolling Fork, Beach and Chaplins Creeks, Floyd's Fork, Kentucky River, Eagle Creek, Elkhorn Creek, Dick's River, Hickman, Paint Lick, and Silver Creeks, Red River, Red Bird Creek, Carr's Fork, Loughery Creek, Great Miami River, White Water River, Licking River, Little Miami River, Scioto River, Salt and Pigeon Creeks, Paint, Clear, Rattlesnake, Buckskin, Deer, and Darby Creeks, Tygart's Creek, Little Sandy River, Big Sandy River, Russell and Louisa Forks, Dry Fork, Tug River, Guyandotte River, Raccoon Creek, Great Kanawha River, Coal River, Elk River, Meadow River, Greenbrier River, Gauley River, New River, Walker's Creek and Little River, Hocking River, Little Kanawha River, Muskingum River, Licking River, Wapetomica, Sims and Wills Creeks, Walbonding River, Tuscarawas River, Duck Creek, Little Muskingum River, Middle Island Creek, Ten Mile, Raccoon, and Buffalo Creeks, Little and Big Beaver Rivers, Conocoanessing, Slippery Rock, Neshannock, and Shenango Creeks, Mahoning River, Monongahela River, Youghiogheny River, Indian and Laurel Hill Creeks, and Castleman's River, Redstone and Ten Mile Creeks, Dunkard's Creek, and Cheat River, Tygart's Valley River, Allegheny River, Kiskiminitas and Conemaugh Rivers, Beaver Run and Loyalhanna Creek, Two Lick and Stone Creeks, Crooked, Mahoning, and Red Bank Creeks, Clarion River, Beaver Mill, and Cooper's Creeks, Venango River, Sugar and Cassewayo Creeks, Findley's Lake, Oil, Caldwell, and Tionesta Creeks, Conewago River, Chautauqua Lake, Cassadaga, Lake. . .	9, 226, 000
Yazoo River (tributary of Mississippi River): Sunflower River, Deer Creek, Yalabusha River, Shooner River, Tapashaw Creek, Cold Water River, Tallahatchie River, Yocoma River, Yazoo Pass, Horn Lake. . .	615, 000		
Arkansas River (tributary of Mississippi River): Bayou Meta, Palarm Creek, Fourche la Pave Creek, Point Remove Creek, Petit Jean Creek, Illinois, Piney, and Mulberry Creeks, Poteau River, Canadian River, Deep Fork of Canadian River, Gains Creek, Illinois River, Osage Creek, Neosho or Grand River, Elk River, Spring River, Shoal and Cow Creeks, Labette, Gooseberry, Big and Little Walnut, Owl, Crooked and Turkey Creeks, Cottonwood Creek, Marle and Muddy Creeks, Verdigris River, Big Caney and North Caney Rivers, Pumpkin, Elk, and Fall Rivers, Bear Creek, Cimarron, Nescutunga, Medicine Lodge, Bluff, and Chikaskia Rivers, Walnut, White Water, and Hickory Creeks, Slate Creek, and Ninnescah River, Little Arkansas River, Cow and Rattlesnake Creeks, Walnut and Pawnee Creeks, Mulberry Creek, Purgatorio or Las Animas River, Huerfano River, St. Charles Creek, Grape Creek. . .	1, 591, 000		
White River (tributary of Mississippi River): La Grue River, Big Creek, Cypress Bayou, and Holloway Lake, Cache River, Little Red River, Black River, Strawberry River, Spring River, Eleven Points River, Current River, Buffalo Fork and Crooked Creek, War Eagle Creek. . .	723, 000		
Ohio River (tributary of Mississippi River): Cache River and Lakes, Humphreys and Massoc Creeks, Tennessee River, Clarks, Bonds, and Blood Creeks, Big Sandy River, White Oak Creek, Duck River, Buffalo Creek, Piney, Swan, Lick, Carter's, and Little Creeks, Beech, Indian, Shoal, and Sugar Creeks, Yellow and Big Bear Creeks, Elk River, Richland Creek, Sequatchie River, Chattanooga, Chickamauga, and Oconee Creeks, Hiawassee River, Clinch River, Emory River, Poplar, Beaver, Cove, and Indian Creeks, Powell's River, Walden Creek, Little Tennessee River, Little River, Tuckasegee River, Oconaluftee River, Nantahala River, Holston River, Watauga River, French Broad River, Pigeon and Great Pigeon Rivers, Nolanchucky River, North and South Toe River, Cumberland River, Little and Red Rivers, Harpeth River, . . .			

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
	Pounds.		Pounds.
MISS. RIVER SYSTEM—Cont'd.		MISS. RIVER SYSTEM—Cont'd.	
Missouri River (tributary of Mississippi River): Gasconade River, Osage River, Pomme de Terre River, Sac River, Marmaton and Little Osage Rivers, Big and Little Sugar, Middle, Bull, Wea, and Ottawa Creeks, Dragon, Rock, and Elm Creeks, Moreau and Moniteau Rivers, Lamine River, Chariton River, Grand River, Kansas River, Stranger Creek, Wakarusa River, Grasshopper River, (or Delaware River), Soldier, Mission, Cross, Mill, Vermillion and Rock Creeks, Big Blue River, Vermillion Creek, Little Blue River, Republican River, Buffalo and Beaver Creeks, Buffalo and White Rock Creeks, Smoky Hill River, Solomon River, Bow Creek, Saline River, Gypsum, Big, Lyon's, Chapman's and Camp Creeks, Platte River, Independence Creek, Nodaway River, Wolf Creek, and Great and Little Nemaha Rivers, Larkio River, Nishnebotene River, Walnut Creek, Keg Creek, Platte River, Elkhorn River, Loup Fork River, North Platte River, Laramie River, Medicine Bow River, South Platte River, Cache la Poudre Creek, Big Thompson Creek, Bear Creek, Mosquito and Pigeon Creeks, Boyer River, and Wall Lake, Soldier River, Little Sioux River, Maple River, Trumbull and Lost Island Lakes, Okoboji, Spirit, and Silver Lakes, Floyd River, Big Sioux River, Rock River, Little Rock River, Lake Kampeska, Vermillion River, James River (or Dakota River), Niobrara River, White River, North Fork of Cheyenne River (or Belle Fourche River), South Fork of Cheyenne River, Yellowstone River, Powder River, Big Horn River, Wind River, Popo Agie River, Milk River	4,421,000	Mississippi River and smaller tributaries—Continued. the Obion and Mayfield Rivers, Big Muddy River, Beaucoup Creek, and Little Muddy River, Union and Jackson County lakes, Kaskaskia River, Kid, Corner, Raynor, Bond, and Long Lakes, Meramec River, Big River, L'ourbeuse River, Saint Mary's, Cahokia, and Piasa Creeks, Cuivre River, Salt River, Bay, Kiset, Sug, and Bear Creeks, North and Fabius Rivers, Lima Lake, Des Moines River, Middle River and Clanton's Creek, Raccoon River, Lake Creek and twin Lakes, Storm Lake, Boone River, Lizzard River, Jack Creek, and Swan Lake, Okamapadu Lake, Skunk River, Cedar Creek, Henderson, Pope, Edwards, and Eliza Creeks, Flint River, Iowa River, Cedar River, Prairie Creek, Otter Creek, Big or Wolf Creek, Black Hawk Creek, Beaver Creek, Shell Rock Creek, Lime Creek, Clear Lake, English River, Salt Creek, Rock River, Green, Milkhoim, and Pine Creeks, and Kishwaukee and Pecatonica Rivers, Cattfish River and Dane County lakes, Jefferson County lakes, Dodge County lakes, Waukesha County lakes, Wapsipinicon River, Mud Creek, Buffalo Creek, Plum, Big rush, and Apple Rivers, Maquoketa River, Catfish Creek, Platte and Grant Rivers, Turkey River, Volga River, Wisconsin River, Kickapoo and Pine Rivers, Baraboo and Lemonwear Rivers, Yellow and Eau Claire Rivers, Rib Rivers, Taylor County lakes, Yellow River, Upper Iowa River, Raccoon River, La Crosse River, Black River, Trempealeau River, Root River, Zumbro River, Buffalo and Eagle Rivers, Chippewa River, Hay and Red Cedar Rivers, Barron County lakes, Chippewa County Lakes, Flambeau River, Cannon River and lakes, Vermillion River, Saint Croix River, Willow, Apple, Trade, Clam, Yellow, and Namekagon Rivers, Polk County lakes, Burnett County lakes, Minnebaha Creek and Minnetonka Lake, Rum River, Elk River, Mille Laes, &c., Crow River and lakes, Pelican Lake and Clear Water Creek and Lake, Sauk River and lakes, Little Rock, Platte, Spunk, Two, Swan, and Elk Rivers, Crow Wing, Prairie, and Leaf Rivers, White Fish, Leech, Cass, Winnibigoshish, and other Lakes	16,304,000
Illinois River (tributary of Mississippi River): Macoupin, Apple, and Crooked Creeks, Sangamon River, Spoon River, Copperas, Kickapoo, and Mackinaw Creeks, Thompson and Spring Lakes, Peoria Lake, Snachwine Lake, Vermillion River, Fox, Pistaqua, Nippersink, and Grass Lakes, Nippersink Creek, White and Honey Rivers, and lakes of Walworth County, Wisconsin, Kankakee River, Iroquois River, Cedar Lake, Du Page, and Des Plaines Rivers	1,040,000	LOUISIANA AND TEXAS.	
Minnesota River (tributary of Mississippi River): Blue Earth, Naple, Cobb, and Watonwan Rivers, and lakes of Blue Earth and other counties, Swan, Timber, &c., lakes, Big Cottonwood River and lakes, Redwood River and lakes, Yellow Medicine River, Chetomica and Chippewa Rivers, Lac-qui-Parle River, Pomme de Terre River, Big Stone Lake	884,000	Barataria Bay	100,000
Mississippi River and smaller tributaries: Homochitto River, Big Black River, Saint Francis River, L'Anguille River, Tyranza River, Little River, Nonconah, Wolf and Loosabatchie Rivers, Big Hatchie River, Tuscumbia River, Forked Deer and Obion Rivers, Reelfoot Lake, Bayou du Chien Creek, Lit-		Timbalier Bay, La Fourche Bayou	132,500
		Caillou Bay	2,500
		Achafalaya River	150,000
		Vermillion River	40,000
		Mermentau River	25,000
		Calcasieu River	15,000
		Sabine River, Neches River, Pine Island, Bayou and Village Creek, Angelina River and Altoac Creek	425,000
		Trinity River; Richland, Pecan, and Chamber's Creeks, Elm and Denton's Forks	540,000

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
LA. AND TEXAS—Continued.		OREGON AND WASHINGTON TERRITORY.	
	<i>Pounds.</i>		<i>Pounds.</i>
Cedar Bayou.....	10, 000	Chetco and Windchuck Rivers.....	120, 000
San Jacinto River; Buffalo Bayou.....	135, 000	Rogue River.....	475, 000
Oyster Bayou.....	10, 000	Port Oxford Lake.....	3, 000
Brazos River; Navasota River, Yegua River, Little Brazos River, Little Leon, and Lampasas Rivers, Elm Fork, Bosque River, Noland's, Patuxy, Kickapoo, Palo Pinto, and Keochi Creeks.....	775, 000	Coquille River.....	400, 000
Caney, Linville, and San Bernard Creeks.....	30, 000	Coos River.....	10, 000
Colorado River: Cumming's Creek, Pedernales River, Llano and San Saba Rivers, Brady's and Pecan Creeks, and Concho River.....	400, 000	Umpqua River.....	950, 000
Caranchua and Trespalacios Creeks.....	25, 000	Sinslaw River.....	15, 000
Lavaca and Navidad Rivers.....	60, 000	Alsea River.....	45, 000
San Antonio and Medina Rivers; Guadalupe River, Sandies Creek, San Marcos River, Plum Creek, and Blanco River, Gibolo Creek.....	225, 000	Yaquina River.....	65, 000
Aransas and Mission Rivers, and Medio and Copano Creeks.....	40, 000	Nestachee River.....	5, 000
Nueces River; Rio Frio.....	45, 000	Nebanan and Nehalem Rivers.....	10, 000
Rio Grande; Rio Pecos, Conejos River; Saguacha River.....	238, 000	Columbia River: Cowlitz River, Tilton River, Lewis River, Willamette River, Klkikitat River, Deschutes River, John Day River, Umatilla River, Walla Walla and Touchit Rivers, Snake River, Palouse River, Tukannon River, Grande Ronde River, Clear Water River, Salmon River, Lemhi River, Payette River and Lake, Boise River, Owyhee River, Bruneau River, Goose Creek, Port Neuf River, Blackfoot River, Salt River, Yakima River, Okinakane, Spokane River and Hangman's Creek, Silver Lake, Crab Creek, Colville River and Pend d'Oreille Creek, Clarke's Fork of Columbia River.....	40, 416, 000
Colorado River; Gila River, Salt River, Rio Verde, White Mountain River, San Pedro River, San Francisco River, Little Colorado River, San Juan River, Rio de las Animas, Rio de los Pinos, Fremont Lake, Grand River, Rio Dolores, Rio San Miguel, Gunnison River, Uncompaggre River, Lake Fork, Tamicki Creek, Blue River, Green River, Fish Lake, Ferron's Creek, Bear or Yampah River, Henry's Fork, Muddy Creek.....	151, 750	Shoalwater Bay and Gray's Harbor.....	500, 000
CALIFORNIA.		Chehalis River: Black River and Newaukum Creek.....	375, 000
San Diego, Santa Margarita, and Santa Ana Rivers.....	12, 000	Quilnet River.....	80, 000
San Gabriel, San Buenaventura, and Ynez Rivers.....	15, 000	Puget Sound: Des Chutes and Nisqually Rivers, Puyallup River, White, Black, Green, Cedar, and Dwamish Rivers, Snoqualmie and Stillaquamish Rivers, Skagit and Samish Rivers, Noosack River....	1, 534, 200
Santa Rosa, San Simeon, and Arroyo del Final Rivers.....	9, 000	TRIBUTARIES OF THE GREAT LAKES.	
Carmel River.....	7, 000	LAKE SUPERIOR.	
Monterey Bay: Salinas River, Nacimiento and San Antonio Rivers.....	150, 000	Brulé and other rivers.....	85, 000
Pajaro River.....	8, 000	Saint Louis River.....	215, 000
Purissima Creek.....	20, 000	Left Hand, Montreal, and other rivers.....	200, 000
San Francisco Bay: Napa and Petaluma Creeks.....	175, 000	LAKE MICHIGAN.	
Sacramento River: San Joaquin River, Calaveras River, and French Camp Slough, Stanislaus River, Tuolumne River, Merced River, Kings River, Tulare Lake, Tule and Kern River, Mokelumne River, Consumnes River, American River, Silver, Blue, and Caples Lakes, Cache Creek, Bartlett's Creek, Clear Lake, Feather River, Bear Creek, Yuba River, Stony, Mill, Deer, and other Creeks, Pitt River, Cow Creek, McCloud River, Goose Lake, &c.....	12, 100, 000	Green Bay: Sturgeon, Escanaba, Ford, and Cedar Rivers, Menominee River, Peshtigo and Oconto Rivers, Pensaukee and Suamico Rivers, and Duck Creek, Fox River, Lake Winnebago, Wolf River, Poygan and Rush Lakes, and Wau-sara County lakes, Waupaca County lakes, Green Lake County lakes, Mecan River and Marquette County lakes, Kewaunee County lakes, Twin Rivers, Manitowoc River, Sheboygan River, Sheboygan County lakes, Milwaukee River, Racine County lakes, Pike Creek, Calumet River and Lake, Saint Joseph River, Elkhart River, Turkey, Wolf, and other lakes, Pigeon River, Honey, Wall, Crooked, and other lakes, Galien Creek, Black and Paw-Paw Rivers, Kalamazoo River, Holland, Pigeon, and Rabbit Rivers, Grand River, Muskegon River, White River, Stoney Creek and Lake, Marquette River, Little and Grand Au Sable Rivers, and Hamlin and Lincoln Lakes, Manistee River, Traverse Bay, Bear, Boyne, Pine, and Jordan Rivers and Lakes, Elk, Round, Torch,	
Russian River.....	300, 000		
Gualala River.....	125, 000		
Garcia River.....	80, 000		
Navarro and Big Rivers.....	180, 000		
Ten Mile Creek.....	45, 000		
Eel River: Van Dusen's, Dobbin's, Connolly's, Larrabee's and Smith's Fork.....	600, 000		
Humboldt Bay: Elk River.....	25, 000		
Mad River.....	100, 000		
Klamath River: Trinity River, Salmon and Shasta Rivers, Lost River, and Tule Lake.....	833, 000		
Smith River.....	400, 000		

Principal and tributary waters.	Annual catch.	Principal and tributary waters.	Annual catch.
TRIBUTARIES OF THE GREAT LAKES—Continued.		MISCELLANEOUS.	
	<i>Pounds.</i>		<i>Pounds.</i>
LAKE MICHIGAN—continued.		Ohio.	
Green Bay—Continued.		Artificial lakes:	
Clam, Grass, and intermediate lakes and rivers, Boardman River, Leelanaw, Benzie, and Grand Traverse County lakes		Paulding County Reservoir.....	
	5, 192, 000	Mercer County Reservoir.....	
LAKE HURON.		Shelby County Reservoir.....	
Cheboygan River.....		Lewistown Reservoir.....	
Devil and Thunder Bay Rivers and Long Lake.....		Licking Reservoir.....	
An Sable River.....		Minnesota and Dakota.	
Saginaw Bay: Pine and Rifle Rivers.		Red River of the North; Two River, Tamarac, Middle, and Snake Rivers, Red Lake River and Lake, Wild Rice River, Sheyenne River, Buffalo, Red, Pelican and Otter-tail Rivers, &c., Rabbit River, Traverse Lake.....	
Saginaw River: Cass River, Tittabawassee River, Flint and Shiawassee Rivers.....		Dakota.	
Pigeon River.....		Devil's Lake.....	
LAKE ERIE.		Spirit Wood Lake.....	
Lake Saint Clair: Clinton River, Saint Clair River, Belle, Pine, and Black Rivers, Detroit River, Rouge River, Huron River, Raisin River, Maumee River, Saint Mary's and Saint Joseph's Rivers, and Tiffin's Creek, Portage River, Sandusky River, Vermillion and Huron Rivers, Rocky and Black Rivers, Cuyahoga River, Chagrin River, Grand River, Ashtabula Creek, Buffalo, Eighteen Mile, and Cattaraugus Creeks.....		Lake Hendricks.....	
	4, 155, 000	Lake Poinsett.....	
LAKE ONTARIO.		Lakes at Norden.....	
Niagara River, Tonawanda Creek, Eighteen Mile, Johnson's, Oak Orchard, Sandy and Salmon Creeks, Genesee River, Oatka Creek, Conesus, Hemlock, Honeoye, and Silver Lakes, Irondequoit Creek,*Sodus Bay and tributaries, Oswego River, Oneida River, Oneida Lake, Fish and Oneida Creeks, Chittenango River, and Cazenovia Lake, Seneca River, Cross Lake, Onondaga Lake, Otisco Lake and outlet, Skaneateles Lake, Owasco River and Lake, Clyde River, Canandaigua Lake, West River, Cayuga Lake, Salmon Creek and Dryden Lake, Seneca Lake, Crooked or Keuka Lake, Salmon River, Sandy and Bedford Creeks, Black River, Beaver River, Moose River, Cham-mont Bay and River.....		Lake Madison.....	
	4, 265, 000	Herman Lake.....	
		Other Dakota lakes.....	
		Utah, Wyoming, and Idaho.	
		Great Salt Lake, Bear River, Malad and Little Malad Rivers, Bear Lake, Weber River, Jordan River, Utah Lake.....	
		Utah.	
		Stockton Lake.....	
		Sevier River.....	
		San Pitch River.....	
		Panquitch River.....	
		Nevada and California.	
		Pyramid Lake, Truckee River, Lake Tahoe.....	
		Walker Lake, Walker River.....	
		Carson River.....	
		Humboldt River, Reese River.....	
		Quin River.....	
		Fähranagat Lake.....	
		California.	
		Owen's River, Gold, Eagle, Honey, and Horse Lakes, &c.....	
		Oregon.	
		Selvies River and Rattlesnake Creek.....	

RECAPITULATION.

States and river systems.	Annual catch.	States and river systems.	Annual catch.
	<i>Pounds.</i>		<i>Pounds.</i>
Maine.....	4, 549, 500	California.....	15, 184, 000
Vermont.....	1, 337, 500	Oregon and Washington Territory.....	45, 003, 200
Massachusetts.....	3, 498, 000	Lake Superior.....	500, 000
Rhode Island.....	1, 011, 000	Lake Michigan.....	5, 192, 000
Connecticut.....	1, 121, 200	Lake Huron.....	1, 005, 000
New York.....	4, 688, 000	Lake Erie.....	4, 155, 000
New Jersey.....	10, 950, 000	Lake Ontario.....	4, 265, 000
Delaware.....	2, 160, 000	Ohio.....	1, 253, 000
Maryland.....	11, 600, 000	Minnesota and Dakota.....	617, 000
Virginia.....	8, 130, 000	Dakota lakes.....	24, 600
North Carolina.....	6, 349, 300	Utah, Wyoming, and Idaho.....	178, 000
South Carolina.....	3, 162, 500	Utah.....	95, 000
Georgia.....	1, 930, 000	Nevada and California.....	1, 186, 500
Florida.....	1, 245, 000	California.....	110, 000
Alabama.....	1, 668, 000	Oregon.....	2, 000
Mississippi and Louisiana.....	1, 922, 000		
Mississippi River system.....	36, 824, 000	Total.....	184, 783, 050
Louisiana and Texas.....	3, 594, 750		



INDEX.

[NOTE.—The references are to page-figures in brackets.]

	Page.		Page.
Acushnet River.....	1	Bayou de Chien Creek.....	5
Agawam River.....	1	Bayou La Batre.....	3
Alabama River.....	3	Bayou L'Arbonne.....	4
Alafia River.....	3	Bayou Meta.....	4
Alamoosook Pond.....	1	Bayou Moro.....	4
Alcora Creek.....	3	Beach Creek.....	4
Allapaha River.....	3	Bean Creek.....	4
Alleghany River.....	4	Bear Branch.....	1
Alloways Creek.....	2	Bear Creek.....	4, 5, 6
Alsea River.....	6	Bear Lake.....	7
Altamaha River.....	3	Bear River.....	6, 7
Altouac Creek.....	5	Bear, or Yampah River.....	6
American River.....	6	Beaucoup Creek.....	5
Amite River.....	3	Beaver Creek.....	4, 5
Ammonoosuc River.....	1	Beaver River.....	4, 7
Anclote River.....	3	Beaverkill River.....	2
Anderson's Creek.....	4	Beaver Mill Creek.....	4
Androsoggin River.....	1	Beaver Run Creek.....	4
Angelina River.....	5	Bedford Creek.....	7
Annesmessex River.....	2	Beech Creek.....	2, 4
Appalachee Creek.....	3	Belgrade Lake.....	1
Apple Creek.....	5	Belle River.....	7
Apple River.....	5	Belle Fourche River.....	5
Appomattox River.....	2	Benzie Lake.....	7
Aquia Creek.....	2	Big Creek.....	4, 5
Aransas River.....	6	Big River.....	5, 6
Arkansas River.....	4	Big Bear Creek.....	4
Arroyo del Final.....	6	Big Beaver River.....	4
Ashepool River.....	3	Big Black River.....	5
Ashley River.....	3	Big Blue River.....	5
Ashtabula Creek.....	7	Big Caney River.....	4
Ashuelot River.....	1	Big Conewago Creek.....	2
Assabet River.....	1	Big Cottonwood Lake.....	5
Atchafalaya River.....	5	Big Cottonwood River.....	5
Au Sable River.....	1, 7	Big Cypress River.....	4
Babb's Creek.....	2	Big Dover Creek.....	3
Back River.....	1, 2	Big Flat Rock Creek.....	4
Badeau Bayou.....	4	Big Hatchie River.....	5
Bald Eagle Creek.....	2	Big Horn River.....	5
Banister River.....	3	Big Muddy River.....	5
Barataria Bay.....	5	Big North Fork of White River.....	4
Barnegat Bay.....	2	Big Rush River.....	5
Bartlett's Creek.....	6	Big Sandy River.....	4
Barton River.....	1	Big Sioux River.....	5
Bass River.....	2	Big Spencer Creek.....	3
Batten Lake.....	2	Big Stone Lake.....	5
Battenkill Creek.....	2	Big Sugar Creek.....	5
Bay Creek.....	5	Big Thompson Creek.....	5
Bay River.....	3	Big Walnut Creek.....	4
Bayou Bartholomew.....	4	Big Wichita River.....	4
Bayou Champagnolle.....	4	Big, or Wolf Creek.....	5

	Page.		Page.
Biloxi River.....	3	Camp Creek.....	3, 5
Black Lake.....	2	Canadian River.....	4
Black River.....	1, 3, 4, 5, 6, 7	Canandaigua Lake.....	7
Blackfoot River.....	6	Cane Creek.....	3
Black Hawk Creek.....	5	Caney Creek.....	4, 6
Blackstone River.....	1	Caney Fork.....	4
Blackwater River.....	2, 3	Canisteo River.....	2
Blanco River.....	6	Cannon Lakes.....	5
Blood Creek.....	4	Cannon River.....	5
Blossom Creek.....	4	Cape Fear River.....	3
Blue Lake.....	6	Caples Lake.....	6
Blue River.....	4, 6	Caranchua Creek.....	6
Blue Earth River.....	5	Carey's Lake.....	2
Bluff River.....	4	Carmel River.....	6
Boardman River.....	7	Carrabasset River.....	1
Boca Diego Bay.....	3	Carr's Fork.....	4
Boggy River.....	4	Carson River.....	7
Bogue Chitto.....	3	Carter's Creek.....	4
Bogue Homo.....	3	Carticay River.....	3
Boise River.....	6	Cashie River.....	3
Bond Lake.....	5	Cass Lake.....	5
Bonds Creek.....	4	Cass River.....	7
Boone River.....	5	Cassadaga Lake.....	4
Bosque River.....	6	Casewago Creek.....	4
Bouquet River.....	1	Castleman's River.....	4
Bourbeuse River.....	5	Catawba Creek.....	2
Bow Creek.....	5	Catawba River.....	3
Bow Secour River.....	3	Catfish Creek.....	5
Boyer River.....	5	Catfish River.....	5
Boyne River.....	6	Catskill Creek.....	1
Brady's Creek.....	6	Cattaraugus Creek.....	7
Brandywine Creek.....	2	Cayuga Lake.....	7
Branford River.....	1	Cayuta Creek.....	2
Brazos River.....	6	Cazenovia Lake.....	7
Briar Creek.....	3	Cedar Bayou.....	6
Broad Creek.....	2	Cedar Creek.....	2, 3, 5
Broad River.....	3	Cedar Lake.....	2, 5
Broad Kill Creek.....	2	Cedar River.....	2, 5, 6
Brule River.....	6	Chagrin River.....	7
Brullet Creek.....	4	Chamber's Creek.....	5
Bruneau River.....	6	Chandler's River.....	1
Buck Creek.....	3	Chaplin's Creek.....	4
Buckskin Creek.....	4	Chapman's Creek.....	5
Budd's Lake.....	2	Chariton River.....	5
Buffalo Bayou.....	6	Charles River.....	1
Buffalo Creek.....	4, 5, 7	Charlotte Creek.....	2
Buffalo River.....	5, 7	Charlotte Harbor.....	3
Bull Creek.....	5	Chateaugay Lake.....	2
Bush River.....	2	Chateaugay River.....	2
Butler Lake.....	3	Chatoga Creek.....	3
Buttahatchie River.....	3	Chattahoochie River.....	3
Byram River.....	2	Chattanooga Creek.....	4
Cache Creek.....	6	Chatuga River.....	3
Cache Lake.....	4	Chaumont Bay.....	7
Cache River.....	4	Chaumont River.....	7
Cache la Poudre Creek.....	5	Chautauqua Lake.....	4
Caddo Creek.....	4	Chazy River.....	1
Caddo Lake.....	4	Cheat River.....	4
Cahawba River.....	3	Chebacco Pond.....	1
Caillou Bay.....	5	Cheboygan River.....	7
Calaveras River.....	6	Cheelelee Creek.....	3
Calcasieu River.....	5	Chehalis River.....	6
Caldwell Creek.....	4	Chenung River.....	2
Caloosahatchie River.....	3	Chenango River.....	2
Calumet Lake.....	6	Chessehowiska River.....	3
Calumet River.....	6	Chest Creek.....	2

	Page.		Page.
Chestatee Creek.....	3	Connolly's Fork.....	6
Chester River.....	2	Conococheague Creek.....	2
Chetco River.....	6	Conodoquinet Creek.....	2
Chetomea River.....	5	Conoquenessing Creek.....	4
Chickahominy River.....	2	Conotowas Creek.....	2
Chickamauga Creek.....	4	Consumnes River.....	6
Chickasawha River.....	3	Contentnea Creek.....	3
Chicopee River.....	1	Coahulla River.....	3
Chieques Creek.....	2	Cooper Creek.....	2
Chikaskia River.....	4	Cooper River.....	3
Chipola River.....	3	Cooper's Creek.....	4
Chippewa River.....	5	Coos River.....	6
Chittanooga River.....	7	Coosa River.....	3
Choctawhatchee River.....	3	Coosawattee River.....	3
Chopawamsic Creek.....	2	Coosawhatchie River.....	3
Choptank River.....	2	Copano Creek.....	6
Chowan River.....	3	Copperas Creek.....	5
Christiana Creek.....	2	Coquille River.....	6
Christians Fork.....	2	Corner Lake.....	5
Cimarron River.....	4	Cottonwood Creek.....	4
Clam Lake.....	7	Cove Creek.....	4
Clam River.....	5	Cow Creek.....	4, 6
Clanton's Creek.....	5	Cowlitz River.....	6
Clarion River.....	4	Cow Pasture River.....	2
Clark River.....	4	Crab Creek.....	6
Clarke's Fork of Columbia River.....	6	Craig Creek.....	2
Clear Creek.....	4	Craig Pond.....	1
Clear Lake.....	5, 6	Cranberry Lake.....	2
Clear Water Creek.....	5	Crocus River.....	4
Clear Water Harbor.....	3	Crooked Creek.....	3, 4, 5
Clear Water Lake.....	5	Crooked Lake.....	6
Clear Water River.....	6	Crooked River.....	1
Clearfield Creek.....	2	Crooked, or Keuka Lake.....	7
Clifty Creek.....	4	Cross Creek.....	5
Clifty River.....	4	Cross Lake.....	7
Clinch River.....	4	Crosswick's Creek.....	2
Clinton River.....	7	Croton Lake.....	1
Clyde River.....	7	Croton River.....	1
Coal Creek.....	4	Crow Lakes.....	5
Coal River.....	4	Crow River.....	5
Coal Fire River.....	3	Crow Wing River.....	5
Coast Ponds.....	1	Crystal River.....	3
Cobb River.....	5	Cuyvre River.....	5
Cobbosseecontee Lake.....	1	Cumberland River.....	4
Cobbosseecontee River.....	1	Cumming's Creek.....	6
Cobscook River.....	1	Current River.....	4
Cocalico Creek.....	2	Cuyahoga River.....	7
Cohansey Creek.....	2	Cypress Bayou.....	4
Cold Water River.....	4	Dakota River.....	5
Colorado River.....	6	Damariscotta River.....	1
Columbia River.....	6	Dan River.....	3
Colville River.....	6	Darby Creek.....	4
Combahee River.....	3	Dead River.....	1
Conch River.....	6	Deep River.....	3
Concoctook River.....	1	Deep Fork of Canadian River.....	4
Concord River.....	1	Deer Creek.....	4, 6
Conecuh River.....	3	Deerfield River.....	1
Conejos River.....	6	Delaware River.....	2, 5
Conemaugh River.....	4	Delia Lake.....	2
Conestoga Creek.....	2	Dennis Creek.....	2
Conesus Lake.....	7	Denny's River.....	1
Conewango River.....	4	Denton's Forks.....	5
Congaree River.....	3	Des Chutes River.....	6
Conhocton River.....	2	Des Moines River.....	5
Connasauga River.....	3	Des Plaines River.....	5
Connecticut River.....	1	Detroit River.....	7

	Page.		Page.
Devil River.....	7	Floyd's Fork.....	4
Devil's Lake.....	7	Ford River.....	6
Dick's River.....	4	Fore River.....	1
Dorcheat Bayou.....	4	Forked Deer River.....	5
Dragon Creek.....	5	Fourche La Fave Creek.....	4
Drakes Fork.....	4	Four-Hole Creek.....	3
Drunkard's Creek.....	4	Fox Lake.....	5
Dryden Lake.....	7	Fox River.....	6
Dry Fork.....	4	Fremont Lake.....	6
Duck Creek.....	4, 6	French Broad River.....	4
Duck River.....	4	French Camp Slough.....	6
Du Page River.....	5	Gains Creek.....	4
Dwamish River.....	6	Galien Creek.....	6
Eagle Creek.....	4	Garcia River.....	6
Eagle Lake.....	7	Gasconade River.....	5
Eagle River.....	5	Gauley River.....	4
East Creek.....	2	Genesee River.....	7
East River.....	2	Gibolo Creek.....	6
East Branch Creek.....	2	Gila River.....	6
Eastern River.....	1	Gold Lake.....	7
East Fork of White River.....	4	Goose Creek.....	2
East Machias River.....	1	Goose Lake.....	6
Eau Pleine River.....	5	Gooseberry Creek.....	4
Echaskotee River.....	3	Graham Creek.....	4
Edisto River.....	3	Grand River.....	4, 5, 6, 7
Edwards Creek.....	5	Grand Au Sable River.....	6
Eel River.....	4, 6	Grande Ronde River.....	6
Eighteen Mile Creek.....	7	Grant River.....	5
Eleven Points River.....	4	Grape Creek.....	4
Eliza Creek.....	5	Grass Lake.....	7
Elizabeth River.....	2	Grass River.....	2
Elk Lake.....	2, 6	Grasshopper River.....	5
Elk Pond.....	2	Gravel Run Creek.....	2
Elk River.....	2, 4, 5, 6	Gray's Harbor.....	6
Elkhart River.....	6	Gray's, or Walker's Pond.....	1
Elkhorn Creek.....	4, 5	Great Blue River.....	4
Elkhorn River.....	5	Great Egg Harbor River.....	2
Ellijay River.....	3	Great Kanawha River.....	4
Ellis Branch.....	1	Great Lehigh River.....	2
Elm Creek.....	5	Great Miami Creek.....	4
Elm Fork.....	6	Great Nemaha River.....	5
Embarras River.....	4	Great Ohoopsee River.....	3
Emory River.....	4	Great Peconic Bay.....	2
English River.....	5	Great Pee Dee River.....	3
Eno River.....	3	Great Pigeon River.....	4
Enoree River.....	3	Great Salt Lake.....	7
Escambia River.....	3	Great Satilla River.....	3
Escanaba River.....	6	Great South Bay.....	2
Esopus Creek.....	1	Great South Pond.....	1
Essex River.....	1	Green Bay.....	6
Etowah River.....	3	Green Creek.....	5
Fabius River.....	5	Green Lake.....	2
Fall Creek.....	4	Green River.....	4, 6
Fall River.....	4	Greenbrier River.....	4
Farmington River.....	1	Greenwood Lake.....	2
Feather River.....	6	Guadalupe River.....	6
Ferron's Creek.....	6	Gualala River.....	6
Findley's Lake.....	4	Gunnison River.....	6
Fish Creek.....	2, 7	Gunpowder River.....	2
Fish Lake.....	6	Guyandotte River.....	4
Fish River.....	3	Gypsum Creek.....	5
Fishing Creek.....	2	Hackensack River.....	2
Flambeau River.....	5	Half-way Pond.....	1
Flat River.....	3	Halifax River.....	3
Flint River.....	3, 5, 7	Hamlin Lake.....	6
Floyd River.....	5	Hampton River.....	2

	Page.		Page.
Hangman's Creek.....	9	Kansas River.....	5
Hardware River.....	2	Kaskaskia River.....	5
Harpeth River.....	4	Keene Pond.....	2
Harrington River.....	1	Keg Creek.....	5
Harris Creek.....	2	Kelley Creek.....	3
Hatchett Creek.....	3	Kennebec River.....	1
Hatcheway Creek.....	3	Kentucky River.....	4
Haw Creek.....	4	Keochi Creek.....	6
Haw River.....	3	Keowee River.....	3
Hay River.....	5	Kern River.....	6
Hemlock Lake.....	7	Kettle Creek.....	2
Henderson Creek.....	5	Kickapoo Creek.....	5, 6
Henry's Fork.....	6	Kickapoo River.....	5
Herman Lake.....	7	Kid Lake.....	5
Hiawasse River.....	4	Kinahafoonnee Creek.....	3
Hickman Creek.....	4	Kinderhook Creek.....	1
Hickory Creek.....	4	Kinderhook Lake.....	1
Hillsboro Bay.....	3	Kings River.....	6
Hillsboro River.....	3	Kiset Creek.....	5
Hockendauga Creek.....	2	Kishwaukee River.....	5
Hocking River.....	4	Kiskiminitas River.....	4
Holland River.....	6	Klamath River.....	6
Holloway Lake.....	4	Klikitat River.....	6
Holston River.....	4	Labette Creek.....	4
Homochitto River.....	5	Lackawaxen River.....	2
Homosassa River.....	3	Lac-qui-Parle River.....	5
Honeoye Lake.....	7	La Crosse River.....	5
Honey Lake.....	6, 7	La Fourche Bayou.....	5
Honey River.....	5	La Grue River.....	4
Hopatcong Lake.....	2	Lake Apopka.....	3
Hop Bottom Creek.....	2	Borgne.....	3
Horn Lake.....	4	Champlain.....	1
Horse Creek.....	3	Conway.....	3
Horse Lake.....	7	Creek.....	5
Houga River.....	2	Crescent.....	3
Housatonic River.....	1	Drummond.....	2
Hudson River.....	1	Erie.....	7
Huerfano River.....	4	Eustis.....	3
Humboldt Bay.....	6	Fork.....	6
Humboldt River.....	7	George.....	1, 3
Humphreys Creek.....	4	Griffin.....	3
Huron River.....	7	Hendricks.....	7
Illinois Creek.....	4	Huron.....	7
Illinois River.....	4, 5	Jessup.....	3
Independence Creek.....	5	Kampeska.....	5
Indian Creek.....	4	Kingsley.....	3
Indian Lake.....	2	Madison.....	7
Indian River.....	1, 2, 3	Maitland.....	3
Indian Stream.....	1	Maurepas.....	3
Iowa River.....	5	Memphremagog.....	1
Ipswich River.....	1	Michigan.....	6
Irondequoit Creek.....	7	Monroe.....	3
Iroquois River.....	5	Norris.....	3
Jack Creek.....	5	Ocklawaha.....	3
Jackson River.....	2	Ontario.....	7
Jamaica Bay.....	2	Poinsett.....	3, 7
James River.....	2, 5	Ponchartrain.....	3
Jessup's River.....	2	Saint Clair.....	7
John Day River.....	6	Superior.....	6
John's River.....	3	Tahoe.....	7
Johnson's Creek.....	7	Weekiwa.....	3
Jones River.....	1	Winnebago.....	6
Jordan River.....	6, 7	Yale.....	3
Juniata River.....	2	Lakes at Norden.....	7
Kalamazoo River.....	6	Lamine River.....	5
Kankakee River.....	5	Lamoille River.....	1

	Page.		Page.
Lamoka Lake.....	2	Logwood Folly River.....	3
Lampasas River.....	6	Long Lake.....	1,5,7
Langley Pond.....	3	Long Pond.....	2
L'Anguille River.....	5	Loosahatchie River.....	5
Laramie River.....	5	Looxapalila River.....	3
Larrabee's Fork.....	6	Lost Creek.....	4
Las Animas River.....	4	Lost River.....	6
Laurel Hill Creek.....	4	Lost Island Lake.....	5
Lavaca River.....	6	Loughery Creek.....	4
Leaf River.....	3,5	Louisa Fork of Big Sandy.....	4
Lebanon Creek.....	2	Loup Fork River.....	5
Leech Lake.....	5	Lower Little River.....	3
Leelenaw Lake.....	7	Loyalhanna Creek.....	4
Left Hand River.....	6	Loyalsock Creek.....	2
Lemhi River.....	6	Lumber River.....	3
Lemonwear River.....	5	Lycoming Creek.....	2
Lewis River.....	6	Lynhaven River.....	2
Lewistown Reservoir.....	7	Lyon's Creek.....	5
Lick Creek.....	5	McBean Creek.....	3
Licking Creek.....	2	McCloud River.....	6
Licking Reservoir.....	7	Machias River.....	1
Licking River.....	4	Mackinaw Creek.....	5
Lima Lake.....	5	Macoupin Creek.....	5
Lime Creek.....	5	Mad River.....	6
Lincoln Lake.....	6	Magothy River.....	2
Linville Creek.....	6	Mahon River.....	2
Little Creek.....	3,4	Mahoning Creek.....	4
Little Lake.....	3	Mahoning River.....	4
Little River.....	1,3,4,5,6	Malad River.....	7
Little Androscoggin River.....	1	Manatee River.....	3
Little Arkansas River.....	4	Manistee River.....	6
Little Barren River.....	14	Manitowee River.....	6
Little Beaver River.....	4	Manitua Lake.....	4
Little Blue River.....	4,5	Manokin River.....	2
Little Brazos River.....	6	Mantau Creek.....	2
Little Choptank River.....	2	Maple Pond.....	2
Little Colorado River.....	6	Maple River.....	5
Little Conewago Creek.....	2	Maquoketa River.....	5
Little Cypress River.....	4	Marle Creek.....	4
Little Flat Rock Creek.....	4	Marmaton River.....	5
Little Kanawha River.....	4	Marquette River.....	6
Little Lehigh River.....	2	Martin Creek.....	2
Little Leon River.....	6	Massoc Creek.....	4
Little Malad River.....	7	Matanzas River.....	3
Little Miami River.....	4	Mattapoissett River.....	1
Little Missouri River.....	4	Mattapony River.....	2
Little Muddy River.....	5	Mattawamkeag River.....	1
Little Muskingum River.....	4	Maumee River.....	7
Little Nemaha River.....	5	Maurice River.....	2
Little Obion River.....	5	Mayfield River.....	5
Little Osage River.....	5	Meadow River.....	4
Little Ossipee River.....	1	Mecan River.....	6
Little Pee Dee River.....	3	Medicine Bow River.....	5
Little Pigeon Creek.....	4	Medicine Lodge River.....	4
Little Red River.....	4	Medina River.....	6
Little Rock River.....	5	Medio Creek.....	6
Little Sandy River.....	4	Meherrin River.....	3
Little Satilla River.....	3	Mekoopang Creek.....	2
Little Sioux River.....	5	Menominee River.....	6
Little Sugar Creek.....	5	Meramec River.....	5
Little Tennessee River.....	4	Merced River.....	6
Little Wabash River.....	4	Merced County Reservoir.....	7
Little Walnut Creek.....	4	Mermenton River.....	5
Little Wichita River.....	4	Merrimac River.....	1
Lizzard River.....	5	Meshoppen Creek.....	2
Llano River.....	6	Messalouskee River.....	1

	Page.		Page.
Meteedeconk River.....	2	Nehalem River.....	6
Mianus River.....	1	Nehanan River.....	6
Micoosukee Lake.....	3	Neosho River.....	4
Middle Creek.....	2,5	Neponset River.....	1
Middle River.....	2,5,7	Nescutunga River.....	4
Middle Island Creek.....	4	Neshaming Creek.....	2
Milk River.....	5	Neshanic River.....	2
Mill Creek.....	5,6	Neshannock Creek.....	4
Mill River.....	1	Nestachee River.....	6
Mille Lacs.....	5	Neuse River.....	3
Miller's River.....	1	Neversink River.....	2
Milwaukee River.....	6	New River.....	3,4
Minnehaha Creek.....	5	New and Clear Fork.....	4
Minnesota River.....	5	Newaukum Creek.....	6
Minnetonka Lake.....	5	Newport River.....	3
Mispyllion Creek.....	2	Niagara River.....	7
Mission Creek.....	5	Ninnescah River.....	4
Mission River.....	6	Niobrara River.....	5
Mississineau River.....	4	Nippersink Creek.....	5
Mississippi River.....	5	Nishnebotene River.....	5
Missouri River.....	5	Nisqually River.....	6
Mobile River.....	3	Nodaway River.....	5
Mohawk River.....	1	Nolanchucky River.....	4
Mokelumne River.....	6	Noland's Creek.....	4
Molechunkemunk River.....	1	Nolin Creek.....	4
Moniteau River.....	5	Nomasket River.....	1
Monocacy River.....	2	Nonconnah River.....	5
Monongahela River.....	4	Noosack River.....	6
Monterey Bay.....	6	North River.....	1,2,5
Montreal River.....	6	North Ann River.....	2
Moose River.....	1,7	North Caney River.....	4
Moosehead Lake.....	1	Northeast River.....	2
Moostocmaguntic Lake.....	1	Northeast Cape Fear River.....	3
Moosup River.....	1	North Fork of Cheyenne River.....	5
Moreau River.....	5	North Newport River.....	3
Moshannon Creek.....	2	North Platte River.....	5
Mosquito Creek.....	5	North Toe River.....	4
Mousam River.....	1	Norwalk River.....	1
Muckhall Creek.....	3	Nottoway River.....	3
Mud Creek.....	4,5	Noxubee River.....	3
Muddy Creek.....	2,4,6	Nueces River.....	6
Muddy River.....	4	Oatka Creek.....	7
Mulberry Creek.....	4	Oakohay Creek.....	3
Mullicus, or Little Egg Harbor River.....	2	Oak Orchard Creek.....	7
Muncy Creek.....	2	Obey's River.....	4
Murder Creek.....	3	Obion River.....	5
Murderkill Creek.....	2	Occoquan River.....	2
Muscatacuc Creek.....	4	Ocilla River.....	3
Musconetcong River.....	2	Ocklawaha River.....	3
Muscongus River.....	1	Ocklockonee River.....	3
Muskegon River.....	6	Ocmulgee River.....	3
Muskingum River.....	4	Oconaluftee River.....	4
Mystic River.....	1	Oconee Creek.....	4
Nacimientto River.....	6	Oconee River.....	3
Namekagon River.....	5	Oconto River.....	6
Nansemond River.....	2	Ocopileo Creek.....	3
Nantahala River.....	4	Ogeechee River.....	3
Nanticoke River.....	2	Ohatchie Creek.....	3
Napal Creek.....	6	Ohio River.....	4
Naple River.....	5	Oil Creek.....	4
Narraguagus River.....	1	Okamanpuda Lake.....	5
Narrowbone River.....	4	Okatoma Creek.....	3
Navarro River.....	6	Okinakane River.....	6
Navasota River.....	6	Okoboji Lake.....	5
Navidad River.....	6	Old Forte Bayou.....	3
Neches River.....	5	Old Man's Creek.....	2

	Page.		Page.
Oneida Creek.....	7	Pecan Creek.....	5, 6
Oneida Lake.....	7	Pecatonica River.....	5
Oneida River.....	7	Peckerwood Creek.....	3
Oneta (Wauneta) Lake.....	2	Pedernales River.....	6
Onondaga Lake.....	7	Peitit Jean Creek.....	4
Opequon Creek.....	2	Pelican Lake.....	5
Orange Lake.....	3	Pelican River.....	7
Orange River.....	3	Pemaquid River.....	1
Osage Creek.....	4	Pemigewasset River.....	1
Osage River.....	5	Pend d'Oreille Creek.....	6
Osahatchee Creek.....	3	Penn's Creek.....	2
Oswegatchie River.....	2	Penobscot River.....	1
Oswego River.....	7	Pensaukee River.....	6
Otego Creek.....	2	Peoria Lake.....	5
Otisco Lake.....	7	Pequest River.....	2
Otisco Outlet.....	7	Perdido Bay.....	3
Otsego Lake.....	2	Perdido River.....	3
Otsetie River.....	2	Perquimans River.....	3
Ottawa Creek.....	5	Peshtigo River.....	6
Otter Creek.....	1, 4, 5	Petaluma Creek.....	6
Otter River.....	4	Pettaquamsutt River.....	1
Ottertall River.....	3	Piankatank River.....	2
Otto River.....	7	Piasa Creek.....	5
Owasco Lake.....	7	Pigeon Creek.....	4, 5
Owasco River.....	7	Pigeon River.....	4, 6, 7
Owen's River.....	7	Pike Creek.....	6
Owl Creek.....	4	Pike Lake.....	4
Owyhee River.....	6	Pine Creek.....	4, 5, 6, 7
Oxbow Lake.....	2	Piney Creek.....	4
Oyster Bay.....	2	Pisacola Creek.....	3
Oyster Bayou.....	6	Piscataquis River.....	1
Pachitta Creek.....	3	Pistagua Lake.....	5
Paddy Creek.....	2	Pithlacoochee Lake.....	3
Pagan Creek.....	2	Pitt River.....	6
Pahrnagat Lake.....	7	Platte River.....	5
Paint Creek.....	3, 4	Pleasant River.....	1
Paint Lick Creek.....	4	Plum Creek.....	6
Pajaro River.....	6	Plum River.....	5
Palarm Creek.....	4	Pocomoke River.....	2
Palmer River.....	1	Point Remove Creek.....	4
Palo Pinto Creek.....	6	Pomme de Terre River.....	5
Palouse River.....	6	Pont Oxford Lake.....	6
Pamanset River.....	1	Pope Creek.....	5
Pamlico River.....	3	Pope Agie River.....	5
Pamunkey River.....	2	Poplar Creek.....	4
Panquitch River.....	7	Portage Creek.....	2
Parker River.....	1	Portage River.....	7
Pascagoula River.....	3	Poteau River.....	4
Pasquotank River.....	3	Potomac River.....	2
Passadumkeag River.....	1	Potowomut River.....	1
Passaic River.....	2	Poultney River.....	1
Patapsco River.....	2	Powder River.....	5
Patoka River.....	4	Poygan Lake.....	6
Patuxent River.....	2	Prairie Creek.....	5
Patuxy Creek.....	6	Prairie River.....	5
Paulding County Reservoir.....	7	Presumpscot River.....	1
Paulinskill River.....	2	Princess Bay.....	2
Pawcatuck River.....	1	Providence River.....	1
Pawlet River.....	1	Puget Sound.....	6
Pawnee Creek.....	4	Pungo River.....	3
Paw-Paw River.....	6	Purgatorio River.....	4
Pawtucket River.....	1	Purissima Creek.....	6
Pawtuxet River.....	1	Pushaw River.....	1
Payette Lake.....	6	Puyallup River.....	6
Pearl River.....	3	Pyramid Lake.....	7
Pease Creek.....	3	Quantico Creek.....	2

	Page.		Page.
Quasapaug River.....	1	Russian River.....	6
Quilent River.....	6	Sabine River.....	5
Quin River.....	7	Sac River.....	5
Quinebaugh River.....	1	Saco River.....	1
Quinnipiac River.....	1	Sacondaga River.....	1
Rabbit River.....	6, 7	Sacramento River.....	6
Raccoon Creek.....	4	Saginaw Bay.....	7
Raccoon River.....	5	Saginaw River.....	7
Racket River.....	2	Saguacha River.....	6
Raisin River.....	7	Saint Andrew's Bay.....	3
Rancocas Creek.....	2	Saint Charles Creek.....	4
Rangeley Lake.....	1	Saint Clair River.....	7
Rapidan River.....	2	Saint Croix River.....	5
Rappahannock River.....	2	Saint Francis River.....	5
Raritan River.....	2	Saint George River.....	1
Rattlesnake Creek.....	4, 7	Saint John River.....	1
Raynor Lake.....	5	Saint John's River.....	3
Rays Fork.....	4	Saint Jones Creek.....	2
Rayston Creek.....	3	Saint Joseph River.....	6
Red River.....	4, 7	Saint Joseph's River.....	7
Red Bank Creek.....	4	Saint Lawrence River.....	2
Red Bird Creek.....	4	Saint Louis River.....	6
Red Cedar River.....	5	Saint Mark's River.....	3
Red Lake Lake.....	7	Saint Mary's River.....	3, 7
Red Lake River.....	7	Saint Mary's Cahokia Creek.....	5
Red River of the North.....	7	Saint Michael's River.....	2
Redstone Creek.....	4	Saint Regis River.....	2
Redwood Lake.....	5	Sakonnet River.....	1
Redwood River.....	5	Salamonia River.....	4
Reelfoot Lake.....	5	Salem Creek.....	2
Reese River.....	7	Salinas River.....	6
Republican River.....	5	Saline River.....	4, 5
Rhode River.....	2	Salmon Creek.....	7
Rib River.....	5	Salmon River.....	1, 2, 6, 7
Richardson River.....	1	Salt Creek.....	4, 5
Richland Creek.....	4, 5	Salt River.....	4, 5, 6
Rifle River.....	7	Saluda River.....	3
Rio de las Animas.....	6	Samish River.....	6
Rio de los Pinos.....	6	Sampson Lake.....	3
Rio Dolores.....	6	San Antonio River.....	6
Rio Frio.....	6	San Bernard Creek.....	6
Rio Grande.....	6	San Buenaventura River.....	6
Rio Pecos.....	6	Sand Creek.....	4
Rio San Miguel.....	6	San Diego River.....	6
Rio Verde.....	6	Sandies Creek.....	6
Rivannah River.....	2	Sandusky River.....	7
River Aux Chenes.....	3	Sandy Creek.....	7
Roanoke River.....	3	Sandy River.....	1
Rock Creek.....	5	Sanford Lake.....	2
Rock Lake.....	2	San Francisco Bay.....	6
Rock River.....	5	San Francisco River.....	6
Rockaway Bay.....	2	San Gabriel River.....	6
Rockcastle River.....	4	Sangamon River.....	5
Rockland Lake.....	4	San Jacinto River.....	6
Rocky River.....	7	San Joaquin River.....	6
Rogue River.....	6	San Juan River.....	6
Rolling Fork.....	4	San Marcos River.....	6
Rondout River.....	1	San Pedro River.....	6
Root River.....	5	San Pitch River.....	7
Rouge River.....	7	San Saba River.....	6
Rough Creek.....	4	San Simeon River.....	6
Round Lake.....	6	Santa Ana River.....	6
Rum River.....	5	Santa Fe Lake.....	3
Rush Lake.....	6	Santa Fe River.....	3
Russell Fork of Big Sandy.....	4	Santa Margarita River.....	6
Russell's Creek.....	4	Santa Rosa River.....	6

	Page.		Page.
Santee River.....	3	Snoqualmie River.....	6
Sapelo River.....	3	Sodus Bay.....	7
Saranac Lake.....	1	Soldier Creek.....	5
Saranac River.....	1	Soldier River.....	5
Sarasota Bay.....	3	Soloman River.....	5
Saratoga Lake.....	2	Songo River.....	1
Sassafras River.....	2	South River.....	1, 2, 3
Saugatuck River.....	1	South Anna River.....	2
Saugus River.....	1	South Fork of Cheyenne River.....	5
Sauk Lakes.....	5	South Fork of Shenandoah River.....	2
Sauk River.....	5	South Newport River.....	3
Savannah River.....	3	South Platte River.....	5
Schoodic Lake.....	1	South Toe River.....	4
Schorarie River.....	1	Spirit Lake.....	5
Schroon Lake.....	2	Spirit Wood Lake.....	7
Schroon River.....	2	Split Lake.....	2
Schuyler's (Canaderaga) Lake.....	2	Spokane River.....	6
Schuylkill River.....	2	Spoon River.....	5
Schwartzwood Lake.....	2	Spring Lake.....	5
Scioto River.....	4	Spring River.....	4
Scuppernong River.....	3	Spunk River.....	5
Sebago Lake.....	1	Stanislaus River.....	6
Sebasticook River.....	1	Staunton River.....	3
Selvies River.....	7	Steinhatchee River.....	3
Seneca Lake.....	7	Stillaquamish River.....	6
Seneca River.....	7	Stockton Lake.....	7
Sequatchie River.....	4	Stone Creek.....	4
Severn River.....	2	Stone River.....	4
Sevier River.....	7	Stoney Creek.....	6
Shark River.....	2	Stoney Lake.....	6
Shasta River.....	6	Stony Creek.....	6
Sheboygan River.....	6	Storm Lake.....	5
Sheepscott River.....	1	Stow Creek.....	2
Shelby County Reservoir.....	7	Stranger Creek.....	5
Shell Rock Creek.....	5	Strawberry River.....	4
Shenandoah River.....	2	Strong River.....	3
Shenango Creek.....	4	Sturgeon River.....	6
Shepaug River.....	1	Suamico River.....	6
Sherman Creek.....	2	Sucarnochee River.....	3
Shetucket River.....	1	Sudbury River.....	1
Shenette River.....	7	Sug Creek.....	5
Shiawassee River.....	7	Sugar Creek.....	2, 3, 4
Shoal Creek.....	3, 4	Sugar River.....	1
Shoalwater Bay.....	6	Sulphur Fork.....	4
Shooner River.....	4	Sunflower River.....	4
Shrewsbury River.....	1	Susquehanna River.....	2
Silver Creek.....	3, 4	Suwannee River.....	3
Silver Lake.....	5, 6, 7	Swamp Creek.....	3
Sims Creek.....	4	Swan Creek.....	4
Sinnemahoning River.....	2	Swan Lake.....	5
Sinslaw River.....	6	Swan River.....	5
Sippican River.....	1	Swift River.....	1
Sipsey River.....	3	Talladega Creek.....	3
Skagit River.....	6	Tallahala Creek.....	3
Skaneateles Lake.....	7	Tallahatchee River.....	4
Skillet Fork.....	4	Tallapoosa River.....	3
Skunk River.....	5	Tallasee Creek.....	3
Slate Creek.....	4	Tallasseehatchee Creek.....	3
Slate River.....	2	Tamarac River.....	7
Slippery Rock Creek.....	4	Tamicki Creek.....	6
Smith River.....	6	Tampa Bay.....	3
Smith's Fork.....	6	Tangipohoa River.....	3
Smith's River.....	3	Tapashaw Creek.....	4
Smoky Hill River.....	5	Tarkio River.....	5
Snachwine Lake.....	5	Taunton River.....	1
Snake River.....	6, 7	Ten Mile Creek.....	4, 6

	Page.		Page.
Tennessee River.....	4	Unadilla River.....	2
Tensas Bayou.....	4	Uncompahgre River.....	6
Tensaw River.....	3	Union River.....	1
Tesantee Creek.....	3	Upper Iowa River.....	5
Thames River.....	1	Upper Little River.....	3
Thompson Lake.....	1, 5	Utah Lake.....	7
Thunder Bay River.....	7	Van Dusen's Fork.....	6
Tibbee River.....	3	Venango River.....	4
Tiffin's Creek.....	7	Verdigris River.....	4
Tiger River.....	3	Vermillion Creek.....	5
Tilton River.....	6	Vermillion River.....	4, 5, 7
Timbalier Bay.....	5	Village Creek.....	5
Timber Lake.....	5	Volga River.....	5
Tioga River.....	2	Wabash River.....	4
Tionesta Creek.....	4	Wacasassa River.....	3
Tioughnioga River.....	2	Waccamaw Lake.....	3
Tippecanoe River.....	4	Waccamaw River.....	3
Tittabawassee River.....	7	Wacissa River.....	3
Toddy Pond.....	1	Wading River.....	2
Tombigbee River.....	3	Wakarusa River.....	5
Tonawanda Creek.....	7	Walden Creek.....	4
Tonis River.....	2	Walen Paupac Creek.....	2
Torch Lake.....	6	Walhonding River.....	4
Touchit River.....	6	Walker Lake.....	7
Towanda Creek.....	2	Walker River.....	7
Town Creek.....	2	Walker's Creek.....	4
Trade River.....	5	Walkill River.....	1
Tradewater River.....	4	Wall Lake.....	5, 6
Transquaking River.....	1	Walla Walla River.....	6
Traverse Bay.....	6	Wallum Lake.....	1
Traverse Lake.....	7	Walnut Creek.....	4, 5
Trempealeau River.....	5	Wapetomica River.....	4
Trent River.....	3	Wapsipinicon River.....	5
Trespacios Creek.....	6	War Eagle Creek.....	4
Trinity River.....	5, 6	Ware River.....	1, 2
Trout River.....	2	Wareham Pond.....	1
Truckee River.....	7	Warren River.....	1
Trumbull Lake.....	5	Warrior Creek.....	3
Tuckahoe River.....	2	Washita River.....	4
Tuckasegee River.....	4	Watauga River.....	4
Tug River.....	4	Wateree River.....	3
Tugaloo River.....	3	Watsonwan River.....	5
Tukannon River.....	6	Wea Creek.....	5
Tulare Lake.....	6	Weber River.....	7
Tule Lake.....	6	Weld Pond.....	1
Tule River.....	6	Wenham Pond.....	1
Tunk River.....	1	West Creek.....	2
Tunkhannock Creek.....	2	West River.....	1, 2, 7
Tuolumne River.....	6	West Canada Creek.....	1
Turkey Creek.....	3, 4	Westfield River.....	1
Turkey Lake.....	6	West Fork of White River.....	4
Turkey River.....	5	Westport River.....	1
Tuscaloosa River.....	3	Wewautitt River.....	1
Tuscarawas River.....	4	White River.....	4, 5, 6
Tuscumbia River.....	5	White Fish Lake.....	5
Twin Lakes.....	5	White Lick Creek.....	4
Twin Rivers.....	6	White Mountain River.....	6
Two River.....	5, 7	White Oak Creek.....	3, 4
Two Lick Creek.....	4	White Oak Pond.....	2
Tygart's Creek.....	4	White Oak River.....	3
Tygart's Valley River.....	4	White Rock Creek.....	5
Tyronza River.....	5	White Water River.....	4
Ty Ty Creek.....	3	Wicomico River.....	2
Umatilla River.....	6	Wild Cat Creek.....	4
Umbagog River.....	1	Wild Rice River.....	7
Umpqua River.....	6	Willamette River.....	6

	Page.		Page.
Willis River.....	2	Yakima River.....	6
Willow Creek.....	3	Yalabusha River.....	4
Willow River.....	5	Yaquina River.....	6
Wills Creek.....	2, 3, 4	Yazoo Pass.....	4
Wind River.....	5	Yazoo River.....	4
Windchuck River.....	6	Yellow Creek.....	4
Winetuxet River.....	1	Yellow River.....	3, 5
Winnibigoshish Lake.....	5	Yellow Leaf Creek.....	3
Winnipiseogee Lake.....	1	Yellow Medicine River.....	5
Winnipiseogee River.....	1	Yellowstone River.....	5
Winooski, or Onion River.....	1	Yequa River.....	6
Winyah Bay.....	3	Ynez River.....	6
Wisconsin River.....	5	Yockanockany River.....	3
Wisserunset River.....	1	Yocona River.....	4
Withcahoochee River.....	3	York River.....	1, 2
Withlocoochee River.....	3	Youghiogheny River.....	4
Wolf Creek.....	3, 5	Young Woman Creek.....	2
Wolf Lake.....	6	Yuba River.....	6
Wolf River.....	3, 5, 6	Zumbro River.....	5
Wye River.....	2		

VI.—STATISTICS OF THE UNITED STATES IMPORTS AND EXPORTS OF FISH, FISH-OIL, WHALEBONE, THE TONNAGE OF FISHING VESSELS, ETC., FOR THE YEAR ENDING JUNE 30, 1883.

By CHAS. W. SMILEY.

A.—IMPORTS.

1. Dutiable.—Quantities and values, by countries.
2. Free.—Quantities and values, by countries.
3. Products of the fisheries.—Quantities and values, by countries.
4. Summary for eleven years.—I. Free. II. Dutiable. (Quantities.)
5. Summary for eleven years.—I. Free. II. Dutiable. (Values.)

B.—EXPORTS.

6. Domestic products.—Quantities and values, by countries.
7. Foreign products.—Quantities and values, by countries.
8. Summary for eleven years.—Quantities. (Domestic products.)
9. Summary for eleven years.—Values. (Domestic products.)
10. Summary for eleven years.—Quantities. (Foreign products.)
11. Summary for eleven years.—Values. (Foreign products.)

C.—TONNAGE.

12. Summary, 1789-1883.—Whale, cod, and mackerel.
13. Cod and mackerel, 1883, by customs districts.
14. Whale, 1883, by customs districts.

The following tables have been prepared from the annual report of the Bureau of Statistics of the Treasury Department, and are based on the custom-house returns.

The clerical work has been performed under my direction by Messrs. M. P. Snell, E. Y. Davidson, and H. P. Jerrell.

TABLE I.—Quantities and values of the dutiable fishery-products imported into the United States during the year ending June 30, 1883.

Countries from which imported.	Fish.				Minor and secondary products.				Grand total.		
	Herring (pickled).		Mackerel (pickled).	Sardines and anchovies preserved in oil.	All other kinds.	Total.	Fish-oil and whale-oil.			Sponges.	Total.
	Barrels.	Dollars.					Barrels.	Dollars.			
Austria.....					Dollars.	Dollars.	Dollars.	Dollars.			Dollars.
China.....					14, 465	6	75, 018	14, 471	8, 000	1, 546	14, 471
Denmark.....	12	65			140	3, 360	3, 565	3, 565	3, 598	2, 335	76, 564
France.....	312	2, 972			683, 467	3, 233	691, 672	691, 672	25	45	5, 900
Germany.....	9, 958	96, 844			4, 487	14, 502	115, 833	115, 833	12, 163	10, 395	691, 717
England.....	37	356			186, 826	5, 749	192, 931	192, 931	8, 579	8, 044	126, 228
Scotland.....	42	615				1, 102	1, 717	1, 717			200, 975
Nova Scotia, New Brunswick, and Prince Edward Island.....						18	18	18	156	76	1, 717
Quebec, Ontario, Manitoba, and the Northwest Territory.....	2, 376	14, 088	19	148		47, 352	61, 588	61, 588	1, 000	569	94
British Columbia.....						104, 752	104, 752	104, 752	47, 060	16, 805	62, 157
Italy.....					801	1, 447	2, 248	2, 248	100	72	121, 537
Japan.....						3, 224	3, 224	3, 224	49, 128	12, 903	2, 320
Netherlands.....	32, 605	361, 303			6, 040	5, 465	373, 808	373, 808			16, 127
Sweden and Norway.....	3, 485	22, 721			1, 892	29, 884	54, 497	54, 497	24, 158	22, 500	372, 808
Other countries.....	6	12			13, 550	24, 951	38, 513	38, 513	2, 055	1, 263	76, 997
Total.....	48, 853	498, 976	19	148	911, 668	322, 063	1, 732, 855	1, 732, 855	156, 022	76, 553	335, 026
											2, 104, 658

TABLE III.—Quantities and values of the products of the fisheries, taken by American vessels and fishermen, brought into the United States during the year ending June 30, 1883.

Products.	Quantities.	Values.
		<i>Dollars.</i>
Of the whale fisheries:		
Sperm-oil.....gallons..	810, 959	847, 996
Other whale-oil.....do.....	946, 938	516, 182
Whalebone or baleen.....pounds..	340, 571	478, 419
Ambergris.....do.....	183	23, 450
Other whale products.....		810
Other products of the American whale fisheries.....		17, 550
Total.....		1, 884, 407
Of other fisheries:*		
Codfish, cured.....cwts.....	278, 521	1, 249, 871
Mackerel, cured.....do.....	192, 619	795, 781
Herring, cured.....do.....	86, 207	134, 199
Other fish, cured.....do.....	57, 680	162, 715
Oysters.....bushels.....	14, 476	21, 202
Other shell-fish.....		240, 372
Fresh fish, not shell-fish.....pounds..	34, 237, 931	1, 159, 778
Oils, other than whale.....gallons..	1, 249, 091	508, 216
Shell and bone, other than whalebone.....		1, 884
Teeth.....pounds.....	19, 646	14, 822
Skins.....number.....	7, 540	5, 125
Manure.....tons.....	18, 422	450, 061
All other products of the American fisheries.....		49, 202
Total.....		4, 793, 228
Total value of products of the American fisheries.....		6, 677, 635

* This information, in regard to fishery-products other than whale, is incomplete, owing to the fact that there is no law requiring all products of the fisheries to be reported to the customs officers when landed within a customs district. It is compiled chiefly from information obtained through the personal efforts and inquiries of the customs officers of the several ports from which it is practicable to obtain returns.

TABLE IV.—Quantities of fish and oil imported into the United States during the eleven years ending June 30, 1883.

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds.....pounds..	8,636,279	9,587,595	15,308,769	10,723,216	7,735,981	9,681,828	8,432,835	10,761,307	12,975,761	15,893,849	16,368,476	126,105,896
Herring, pickled.....barrels..	.....	51,423	70,763	87,554	63,280	58,082	55,732	46,723	64,811	76,136	101,344	675,848
Mackerel, pickled.....barrels..	.....	89,503	77,479	76,531	43,066	102,148	101,420	112,468	120,288	58,279	52,093	833,275
Oils:												
Whale or fish, not of American fisheries.....gallons.....	.....	165,448	277,739	103,184	138,708	311,091	182,625	407,410	568,660	337,076	376,608	2,818,555
II.—DUTYABLE.												
Fish, not of American fisheries:												
Herring.....barrels..	68,692	31,128	21,581	17,268	14,873	15,542	18,950	26,168	30,987	36,061	48,833	330,083
Mackerel.....barrels..	90,889	190	59	7	14	6	2	.....	9	164	19	91,359
Oils:												
Whale and fish, not of American fisheries.....gallons.....	223,612	226,528	115,084	102,883	51,882	85,509	61,509	92,819	146,410	209,051	156,022	1,471,309

TABLE V.—*Values of the fish and oil imported into the United States during the eleven years ending June 30, 1883.*

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds	\$278,921	\$294,837	\$351,889	\$271,597	\$236,098	\$339,561	\$283,827	\$320,403	\$376,508	\$488,925	\$572,526	\$3,815,092
Herring, pickled	(a)	181,521	288,690	306,555	210,786	230,533	192,069	154,003	236,402	265,797	418,323	2,484,580
Mackerel, pickled	(a)	800,920	584,283	695,412	372,260	937,246	649,721	493,059	614,729	396,149	427,327	3,941,166
All other not elsewhere specified	(b)	553,949	928,344	501,154	581,592	637,437	763,915	912,336	1,088,336	1,366,963	1,774,646	9,108,672
Oils:												
Whale or fish, not of American fisheries	(b)	91,944	161,289	62,438	84,088	176,384	80,701	170,525	293,600	158,878	203,611	1,488,458
Total	278,921	1,923,171	2,314,395	1,837,156	1,484,824	2,291,161	1,970,233	2,050,326	2,609,576	2,676,712	3,396,473	22,832,908
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring, pickled	359,262	253,044	226,494	180,535	189,615	180,840	189,204	288,407	290,073	375,617	498,976	3,038,067
Mackerel, pickled	610,457	1,550	553	48	148	67	14	.....	97	1,179	148	614,261
Sardines and anchovies preserved												
in oil or otherwise	1,172,704	991,030	526,179	595,901	773,331	677,910	912,391	1,102,410	987,394	880,760	911,668	9,511,678
All other not elsewhere specified	663,913	131,676	102,283	96,046	91,654	149,852	118,050	132,684	142,158	294,606	322,063	2,244,985
Oils:												
Whale and fish, not of American fisheries	106,294	121,927	70,404	63,286	44,015	56,616	45,903	55,133	82,584	103,020	76,553	825,735
Total	2,912,630	1,499,227	925,913	941,816	1,098,763	1,085,285	1,265,562	1,578,634	1,502,306	1,635,182	1,809,408	14,284,726

b. Included in dutiable, same class.

a. Included in dutiable "Fish, other."

TABLE VI.—Quantities and values of the domestic fishery-products exported from the United States during the year ending June 30, 1883.

[illegible]

TABLE VIII.—Quantities of fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June 30, 1883.

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
Fish:												
Dried or smoked	118, 076	129, 982	129, 752	175, 528	159, 648	188, 831	179, 130	197, 450	212, 691	159, 512	158, 445	1, 809, 045
Picked	16, 747	23, 000	51, 025	54, 281	76, 227	57, 554	47, 704	54, 345	52, 092	38, 224	48, 551	525, 850
Oils:												
Whale and other fish	288, 263	573, 775	885, 907	1, 067, 515	1, 026, 038	904, 988	2, 236, 265	1, 022, 889	597, 812	1, 083, 925	226, 983	9, 924, 360
Sperm	756, 306	829, 903	491, 130	892, 762	634, 991	723, 398	812, 928	482, 153	314, 568	540, 064	275, 021	6, 483, 224
Spermaceti	197, 871	304, 865	238, 641	141, 157	153, 552	228, 276	147, 503	197, 847	214, 205	265, 593	396, 869	2, 486, 179
Whalebone	324, 653	114, 530	251, 572	154, 500	71, 708	154, 016	78, 322	131, 332	227, 117	220, 787	826, 835	2, 055, 372

TABLE IX.—Values of fish, oils, spermaceti, and whalebone exported from the United States during the eleven years ending June 30, 1883.

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
Fish:												
Fresh	\$64, 577	\$56, 974	\$69, 448	\$80, 879	\$114, 338	\$84, 278	\$80, 437	\$124, 982	\$97, 539	\$89, 148	\$72, 875	\$935, 455
Dried and smoked	569, 151	612, 589	710, 121	900, 306	791, 785	766, 154	748, 747	739, 231	840, 199	635, 155	882, 830	8, 196, 268
Picked	109, 201	226, 041	359, 669	417, 281	486, 738	416, 162	290, 862	284, 293	264, 723	244, 454	372, 385	3, 471, 809
Other cured	677, 171	1, 128, 208	1, 855, 550	2, 102, 522	2, 486, 225	3, 198, 896	2, 939, 587	2, 326, 444	2, 803, 330	3, 218, 581	3, 202, 412	25, 938, 926
Oils:												
Whale and other fish	154, 243	280, 750	413, 411	436, 072	442, 165	411, 808	756, 248	349, 109	229, 726	420, 730	115, 490	4, 009, 752
Sperm	1, 095, 831	827, 991	847, 014	1, 366, 246	879, 865	801, 218	719, 831	487, 004	303, 113	551, 212	290, 417	8, 169, 742
Spermaceti	55, 815	78, 346	61, 725	35, 915	41, 027	58, 302	35, 489	45, 018	40, 945	48, 721	66, 651	567, 954
Whalebone	329, 214	115, 098	291, 165	215, 327	160, 666	264, 980	199, 753	255, 847	326, 400	325, 333	599, 550	3, 083, 333
Total	3, 055, 203	3, 325, 997	4, 608, 103	5, 554, 548	5, 402, 809	6, 001, 798	5, 770, 954	4, 611, 908	4, 905, 975	5, 533, 334	5, 602, 610	54, 373, 239

TABLE X.—Quantities of foreign fish and oils exported from the United States during the eleven years ending June 30, 1883.

Description.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds..... pounds			66,728	2,885	1,903	21			624	101	179	66,728
Herring, pickled..... barrels	(a)	233	2,318	885	1,903	356	171	272	842	60	108	8,264
Mackerel, pickled..... barrels	(a)	35	1,300									4,029
Oils:												
Whale or fish, not of American fisheries, gallons.....	(a)				43,103	379,570			380	10,794		434,347
II.—DUTIABLE.												
Fish, not of American fisheries:												
Herring..... barrels	19,928	4,271	43		- 2							24,244
Mackerel..... barrels	36,146	5,334									89	41,569
Oils:												
Whale or fish, not of American fisheries, gallons.....	35,016	73,429	29,246	52,736	1,705	8,800	5,245	602	7,939	11,560	1,851	228,149

a. Included in dutiable, same class.

TABLE XI.—Values of foreign fish and oils exported from the United States during the eleven years ending June 30, 1883.

Description.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	Total.
I.—FREE OF DUTY.												
Fish, not of American fisheries:												
Fresh, of all kinds.....			\$3,895	\$13,305	\$9,088	\$71						\$3,895
Herring, pickled.....	(a)	\$1,157	11,576	4,515	\$9,088	2,279	\$684	\$1,260	\$1,770	\$381	\$737	38,085
Mackerel, pickled.....	(a)	358	10,254	4,515	32,120	76,144	206,440	188,265	3,889	360	870	29,469
All other not elsewhere specified.....	(a)	29,411	133,620	39,618					59,501	53,644	103,587	922,360
Oils:												
Whale or fish, not of American fisheries.....	(a)				26,669	217,562			475	4,715		249,421
Total.....		30,926	150,345	57,438	67,877	296,056	207,124	189,525	65,635	59,100	105,204	1,296,230
II.—DUTIABLE.												
Fish, not of American fisheries:					22							
Herring, pickled.....	\$81,775	16,650	146									98,593
Mackerel, pickled.....	178,328	29,429									719	208,476
Sardines and anchovies preserved in oil or otherwise.....	45,452	59,796	23,296	19,667	24,780	30,455	29,149	36,000	45,839	47,833	35,113	397,380
All other not elsewhere specified.....	213,594	35,803	23,433	55,905	135,854	116,266	54,954	13,632	69,063	212,620	178,874	1,109,938
Oils:					794	8,058	2,363	331	3,334	8,848	2,136	117,379
Whale or fish, not of American fisheries.....	25,601	34,196	11,236	29,482								
Total.....	544,690	175,874	58,111	96,054	161,450	154,779	86,466	49,963	118,236	269,301	216,542	1,931,766

a. Included in dutiable, same class.

TABLE XII.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from 1789 to 1883.*

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending December 31—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1789				9,062		9,062		9,062
1790				28,348		28,348		28,348
1791				32,542		32,542		32,542
1792				32,062		32,062		32,062
1793				28,974	1,985	30,959		30,959
1794		4,129	4,129	17,498	5,550	23,048		27,177
1795		3,163	3,163	24,887	6,046	30,933		34,096
1796		2,364	2,364	28,509	6,453	34,962		37,326
1797		1,104	1,104	33,406	7,222	40,628		41,732
1798		763	763	35,477	7,269	42,746		43,509
1799	5,055	592	5,647	23,933	6,046	29,979		35,626
1800	2,814	652	3,466	22,307	7,120	29,427		32,893
1801	2,349	736	3,085	31,280	8,102	39,382		42,467
1802	2,621	580	3,201	32,988	8,534	41,522		44,723
1803	11,247	1,143	12,390	43,416	8,396	51,812		64,202
1804	12,016	323	12,339	43,088	8,926	52,014		64,353
1805	5,117	898	6,015	48,479	8,986	57,465		63,480
1806	9,778	729	10,507	50,353	8,830	59,183		69,690
1807	8,144	907	9,051	60,690	9,616	70,306		79,357
1808	3,802	724	4,526	43,598	8,400	51,998		56,524
1809	3,204	573	3,777	26,110	8,377	34,487		38,264
1810	3,250	339	3,589	26,251	8,577	34,828		38,417
1811	5,245	54	5,299	34,361	8,873	43,234		48,533
1812	1,988	942	2,930	21,822	8,637	30,459		33,389
1813	2,153	789	2,942	11,255	8,622	19,877		22,819
1814		562	562	8,863	8,992	17,855		18,417
1815		1,230	1,230	26,510	10,427	36,937		38,167
1816		1,168	1,168	37,879	10,247	48,126		49,294
1817	4,874	350	5,224	33,990	10,817	64,807		70,031
1818	16,135	615	16,750	58,552	10,555	69,107		85,857
1819	31,700	686	32,386	65,045	11,033	76,078		108,464
1820	35,391	1,054	36,445	60,843	11,197	72,040		108,485
1821	26,071	1,924	27,995	51,352	10,941	62,293		90,288
1822	45,449	3,134	48,583	58,405	10,821	69,226		117,809
1823	39,918	585	40,503	67,041	11,214	78,255		118,756
1824	33,166	180	33,346	68,239	9,208	77,447		110,793
1825	35,379		35,379	70,626	10,836	81,462		116,841
1826	41,757	227	41,984	63,535	10,121	73,656		115,640
1827	45,653	339	45,992	73,709	10,230	83,939		129,931
1828	54,621	180	54,801	74,765	10,922	85,687		140,488
1829	57,284		57,284	97,889	3,908	101,797		159,081
1830	38,912	793	39,705	58,041	3,515	61,556	35,973	137,234
1831	82,316	481	82,797	57,239	3,739	60,978	46,211	189,986
1832	72,869	377	73,246	51,725	3,303	55,928	47,428	175,702
1833	101,158	478	101,636	58,569	4,152	62,721	48,726	213,083
1834	108,060	364	108,424	52,473	3,931	56,404	61,082	225,910
Year ending September 30—								
1835*	97,649		97,649	72,374	4,964	77,338	64,443	239,430
1836	144,681	1,573	146,254	58,414	4,893	63,307	46,424	255,985
1837	127,242	1,895	129,137	75,055	5,497	80,552	46,811	256,500
1838	119,630	5,230	124,860	63,974	6,090	70,064	56,649	251,573
1839	131,845	440	132,285	65,167	7,091	72,258	35,984	240,527
1840	136,927		136,927	67,927	8,109	76,036	28,269	241,232
1841	157,405		157,405	60,556	5,996	66,552	11,321	235,278
1842	151,613	377	151,990	49,942	4,863	54,805	16,097	222,892
Year ending June 30—								
1843*	152,375	142	152,517	54,901	6,323	61,224	11,776	225,517
1844	168,294	320	168,614	78,179	7,046	85,225	16,171	270,010
1845	190,696	207	190,903	69,826	7,165	76,991	21,414	289,308
1846	186,980	440	187,420	72,516	6,802	79,318	36,463	303,201
1847	193,859		193,859	70,178	7,503	77,681	31,451	302,991
1848	192,180	433	192,613	82,652	7,195	89,847	43,558	326,018
1849	180,186		180,186	73,882	7,874	81,756	42,942	304,884
1850	146,017		146,017	85,646	8,160	93,806	58,112	297,935
1851	181,644		181,644	87,476	8,141	95,617	50,539	327,800
1852	193,798		193,798	102,659	7,914	110,573	72,546	376,917
1853	193,203		193,203	99,990	9,238	109,228	59,850	362,281
1854	181,901		181,901	102,194	9,734	111,928	35,041	328,870
1855	186,778	70	186,848	102,928	8,987	111,915	21,625	320,388
1856	189,213	248	189,461	95,816	6,636	102,452	29,887	321,800

* Nine months.

TABLE XII.—*Tonnage of the United States vessels employed in the cod, mackerel, and whale fisheries from 1789 to 1883.—Continued.*

Period.	Whale fisheries.			Cod fisheries.			Mackerel fisheries.	Total.
	Registered vessels.	Enrolled vessels.	Total.	Enrolled vessels.	Licensed vessels (under 20 tons).	Total.		
Year ending June 30—	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
1857.....	195, 772	70	195, 842	104, 573	7, 295	111, 868	28, 328	336, 038
1858.....	198, 594		198, 594	110, 896	8, 356	119, 252	29, 594	347, 440
1859.....	185, 728		185, 728	120, 577	9, 060	129, 637	27, 070	342, 435
1860.....	166, 841		166, 841	127, 508	9, 145	136, 653	26, 111	329, 605
1861.....	145, 734		145, 734	127, 311	10, 535	137, 846	54, 795	338, 375
1862.....	117, 714		117, 714	122, 863	10, 738	133, 601	80, 596	331, 911
1863.....	99, 228		99, 228	106, 560	10, 730	117, 290	51, 019	267, 537
1864.....	95, 145		95, 145	92, 745	10, 997	103, 742	55, 499	254, 386
1865.....	84, 233	6, 283	90, 516	59, 227	5, 958	65, 185	41, 209	196, 910
1866.....	105, 170		105, 170	42, 797	8, 845	51, 642	46, 589	203, 401
1867.....	52, 384		52, 384	36, 709	7, 858	44, 567	31, 498	128, 449
1868.....	71, 343		71, 343	74, 763	9, 124	83, 887	(*)	155, 230
1869.....	70, 202		70, 202	55, 165	7, 539	62, 704		132, 906
1870.....	67, 954		67, 954	82, 612	8, 848	91, 460		159, 414
1871.....	61, 490		61, 490	82, 902	9, 963	92, 865		154, 355
1872.....	51, 608		51, 608	87, 403	10, 144	97, 547		149, 155
1873.....	44, 755		44, 755	99, 542	9, 977	109, 519		154, 274
1874.....	39, 108		39, 108	68, 490	9, 800	78, 290		117, 398
1875.....	38, 229		38, 229	68, 703	11, 504	80, 207		118, 436
1876.....	39, 116		39, 116	77, 314	10, 488	87, 802		126, 918
1877.....	40, 593		40, 593	79, 678	11, 407	91, 085		131, 678
1878.....	39, 700		39, 700	71, 560	14, 987	86, 547		126, 247
1879.....	40, 028		40, 028	66, 543	13, 342	79, 885		119, 912
1880.....	38, 408		38, 408	64, 935	12, 603	77, 538		115, 946
1881.....	38, 551		38, 551	66, 365	9, 771	76, 136		114, 687
1882.....	32, 802		32, 802	67, 014	10, 848	77, 862		110, 664
1883.....	32, 414		32, 414	84, 322	10, 716	95, 038		127, 452
Total	6, 746, 456	53, 959	6, 800, 415	5, 947, 315	767, 475	6, 714, 790	1, 549, 101	15, 064, 306

* Included under cod fisheries since 1867.

TABLE XIII.—*Number and tonnage of vessels of the United States employed in the cod and mackerel fisheries June 30, 1883.*

State.	Customs district in which documented.	Vessels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Maine	Passamaquoddy	115	13, 268. 25	24	301. 56	139	13, 669. 81
	Machias.....	8	266. 83	22	283. 18	30	550. 01
	Frenchman's Bay	27	1, 385. 58	32	346. 15	59	1, 731. 73
	Castine.....	36	2, 134. 09	28	355. 85	64	2, 489. 94
	Bangor.....			4	60. 41	4	60. 41
	Belfast.....	26	1, 323. 09	34	373. 11	60	1, 696. 20
	Waldoborough	72	2, 804. 53	84	1, 072. 34	156	3, 876. 87
	Wiscasset.....	35	1, 946. 44	44	512. 89	79	2, 459. 33
	Bath.....	1	31. 00	11	113. 17	12	144. 17
	Portland and Falmouth	113	6, 522. 15	38	502. 34	151	7, 024. 49
	Saco.....	1	31. 30	6	53. 79	7	85. 09
	Kennebunk.....	6	189. 70	11	113. 15	17	302. 85
	York.....	1	34. 10	5	49. 11	6	83. 21
	Portsmouth.....	29	5, 753. 10	6	79. 35	35	5, 832. 45
New Hampshire.... Massachusetts....	Newburyport	10	331. 24	9	94. 29	19	425. 53
	Gloucester.....	343	21, 633. 62	68	809. 92	411	22, 443. 54
	Salem and Beverly	13	865. 15	12	140. 08	25	1, 005. 23
	Marblehead.....	21	1, 111. 09	16	179. 47	37	1, 290. 56
	Boston and Charlestown	51	3, 015. 16	10	77. 18	61	3, 092. 34
	Plymouth.....	9	606. 61	14	139. 58	23	746. 19
	Barnstable.....	174	14, 107. 43	41	452. 40	215	14, 559. 83
	Nantucket.....			11	68. 10	11	68. 10
	Edgartown.....			3	18. 37	3	18. 37
	New Bedford.....	9	608. 00	45	466. 37	54	1, 074. 37
	Fall River.....	3	131. 11	17	211. 99	20	343. 10

TABLE XIII.—Number and tonnage of vessels of the United States, &c.—Continued.

State.	Customs district in which documented.	Vesels above 20 tons.		Vessels under 20 tons.		Total.	
		No.	Tons.	No.	Tons.	No.	Tons.
Rhode Island	Providence			42	333.07	42	333.07
	Bristol and Warren			4	34.24	4	34.24
	Newport	16	934.09	47	486.30	63	1,420.39
Connecticut	Stonington	25	993.88	40	409.25	65	1,403.13
	New London	23	1,193.12	34	457.09	62	1,650.21
New York	New York	18	851.65	106	714.12	124	1,565.77
	Sag Harbor			87	865.29	87	865.29
New Jersey	Little Egg Harbor	1	25.65	3	51.01	4	76.66
Maryland	Baltimore	34	1,222.00			34	1,222.00
Virginia	Tappahannock	6	246.17	30	285.20	36	531.37
North Carolina	New Berne	2	44.87	4	50.57	6	95.44
Florida	Pensacola	8	497.63	3	37.98	11	535.61
Alabama	Mobile	2	66.89	4	70.43	6	137.32
California	San Diego	2	46.33	4	42.40	6	88.73
	San Francisco			1	5.27	1	5.27

SUMMARY.

Maine	441	30,037.06	343	4,137.05	784	34,174.11
New Hampshire	29	5,753.10	6	79.35	35	5,832.45
Massachusetts	633	42,409.41	246	2,657.75	879	45,067.16
Rhode Island	16	934.09	93	853.61	109	1,787.70
Connecticut	53	2,187.00	74	866.34	127	3,053.34
New York	18	851.65	193	1,579.41	211	2,431.06
New Jersey	1	25.65	3	51.01	4	76.66
Maryland	34	1,222.00			34	1,222.00
Virginia	6	246.17	30	285.20	36	531.37
North Carolina	2	44.87	4	50.57	6	95.44
Florida	8	497.63	3	37.98	11	535.61
Alabama	2	66.89	4	70.43	6	137.32
California	2	46.33	5	47.67	7	94.00
Total	1,245	84,321.85	1,004	10,716.37	2,249	95,038.22

TABLE XIV.—Number and tonnage of vessels of the United States employed in the whale fisheries June 30, 1883.

State.	Customs district in which documented.	Number.	Tons.
Massachusetts	Boston	5	794.87
	Barnstable	12	1,126.63
	Edgartown	5	891.28
	New Bedford (sail)	110	27,602.44
	New Bedford (steam)	3	1,298.39
Connecticut	New London	6	700.44
Total		141	32,414.05

VII.—ON THE FISHERIES OF GREAT BRITAIN AND THE FISHERIES EXHIBITION OF 1883.

By R. W. DUFF, M. P.

[Abstract, by Chas. W. Smiley, of a lecture at Cullen, Scotland, January 3, 1883.]

The proposal to hold a great International Fisheries Exhibition in London was strengthened by the success which attended similar undertakings in Berlin, Norwich, and Edinburgh. These exhibitions were all extremely useful. They were the means of bringing valuable inventions before the public, and of suggesting improvements in important branches of fishing and maritime industry. They were also financially successful; in each case there were surpluses, ranging from £1,400 to £2,000. The Berlin Exposition was open only ten weeks; and in that time it was visited by 483,000 people. We propose to keep the London Exhibition open for six months. The population of London and the suburbs is now about 5,000,000; that of Berlin, only 1,100,000. We may therefore look forward to the number of our visitors running into millions.

The origin of the Exhibition was the result, in a great degree, of the success of the Norwich Exhibition. The proposal to promote a similar undertaking on a larger scale in London during the present year emanated from Mr. Birkbeck, M. P., and some members of the Fishmongers' Company of London. A preliminary meeting was held in the Fishmongers' Hall in July, 1881, when the Fishmongers' Company gave £500 to the prize fund and £2,000 to the guaranty fund, and appointed Mr. Birkbeck, who had acted with great ability as chairman of the Norwich Exhibition, to the chairmanship of the executive committee. That committee, limited to twelve, was composed of the representatives of the various fishery interests of the kingdom. The Marquis of Hamilton, as representing Ireland, and Sir A. T. Galt, as representing Canada, have since been added to the executive committee, while the duty of representing Scotland has devolved upon me. We succeeded in securing the support of royalty, Her Majesty the Queen graciously consenting to be patron, while the Prince of Wales became president, and the Duke of Edinburgh, our sailor prince, appropriately acting as our vice-president; the Duke of Richmond and Gordon, whose business abilities I am sure you all recognize, becoming chairman of our general committee. As foreign minister, Lord Granville offered us every assistance in bringing our project before foreign countries.

The Exhibition building stands on 23 acres of ground in the Horticultural Gardens, within three minutes' walk of a railway station. In

the open spaces in the gardens there will be fountains, large tanks containing various descriptions of live sea and fresh-water fish, full-sized fishing-boats, models of life-boats, including steam life-boats, full-sized fish-markets, and refrigerating vans for the conveyance of fish. In the covered space, extending over more than 300,000 square feet, will be shown the various exhibits, classed under seven different heads and sixty-one different divisions. In the building in which the Exhibition is to be held the committee have already authorized an expenditure of £20,000. We have a guaranty fund of £22,000. America is spending £10,000 on her exhibits; and, looking to the long list of foreign countries that are competing, at least £100,000 will be spent in what they are sending us. America, Canada, Newfoundland, Norway, Sweden, the Netherlands, and Belgium apply for an average of 10,000 square feet each for their exhibits; while China, Japan, India, Chili, and New South Wales take together 30,000 square feet. From the United States we may hope to learn a good deal about the artificial propagation of deep-sea fish. Canada and Newfoundland, as British fishing-grounds, are second to none. They possess a fishing coast of over 4,000 miles; and Sir A. Galt tells us that they produce £5,000,000 a year, and employ 90,000 men and boys. From an industry conducted on so large a scale we may expect to learn something, and possibly the mother country may be able to impart some knowledge to her promising and hardy sons on the other side of the Atlantic. An important fish trade has recently sprung up with the west coast of America. The canned fish trade with the Pacific coast has risen from 4,000 cases in 1866 to 928,000 cases in 1882. The total amount of salmon exported from the same quarter is 45,000,000 pounds.

In a part of the building set aside for the purpose will be shown in active operation the process of curing fish. I believe Scotland, Germany, and Holland are the chief competitors in this section. I have great doubt if anything in the shape of cured fish can be procured to compete with a kippered herring or a Finnan haddock. An effort will be made to introduce into the London market and make more popular what are termed the inferior classes of fish. Now, to appreciate the full importance of this subject I must ask you to bear in mind what an enormous place London has become. Including the suburbs it contains a population of five millions. Living within a radius of twelve miles you have a population nearly equal to the whole of that of Ireland, a third larger than the whole population of Scotland, and twelve times as large as the population of Glasgow. The amount of fish annually consumed in London is upwards of 130,000 tons, equal to 1,000 bullocks daily during the 313 working days of the year, and representing 90 pounds of fish per annum for every man, woman, and child in the metropolis. This large consumption has been attained in spite of the high railway rates and extremely defective market arrangements; but large as the present consumption of fish is, the demand goes on increasing,

and an opinion prevails that the demand might in some degree be met by educating the palate of the London fish consumer to appreciate what are known in the metropolitan market as the inferior classes of fish. We have enlisted the sympathies and secured the services of the managers of the School of Cookery at South Kensington; they have undertaken to cook and present in the cheapest and most palatable form at breakfasts and luncheons to be served in the Exhibition, dishes of the inferior fish. Now the importance of this will be understood when we look at the prices paid for first and second-class qualities in London. Following is a list of the average prices, taking all the year round, at Billingsgate: Sole, salmon, brill, gray mullet, John Dory, whiting, and eels average 1s. per pound; haddock, sprats, cod, herring, coalfish, plaice, ling, and hake on an average bring only 2d. per pound. Now nobody but a cockney would give six times the price for a sole or a whiting that he would for a haddock, or even a good fresh herring; but the fact is these second-class fish are not much known in the West End. By presenting them in a dainty form, we hope to show that they are not inferior to fish that command exorbitant prices, and if we can succeed in doing this we shall benefit alike the London fish consumers and the fishermen on the coast. Fifty per cent is the average deduction you have to make in this part of the country on your sales of fresh fish in London for railway rates and commission. Sometimes the whole proceeds of a sale are swallowed up by these two items, leaving absolutely no profit to the fishermen. The committee recommend that the railway commission be made permanent, and that on the application of traders the commission have power to order through rates; but this power is not to enable the commission to order lower rates than the limit at present charged. The railway commission is to hold sittings in Scotland. This is not a large concession, yet it might prevent the excessive rates; and although uniform rates are, in the opinion of the committee, impracticable, yet we look to the action of the commission to lower the rates and to diminish the anomalies, which a comparison of the rates in different localities at present presents. For instance, the Caledonia Railway charged four times the mileage between Montrose and Glasgow that it charged in through rates to London. Even the competition of sea traffic to London ought not to make so great a difference as this, and we may look to the action of the commission and the legislation that will follow the report of the committee for some measure of redress. The question of rates forms part of a subject for which the Exhibition committee offer a prize of £100 in the essay department.

Improved fishmarkets are needed in many places, but particularly in London. In Mr. Spencer Walpole's report to the Home Secretary in 1881 he mentions that in the seventeen months preceding December, 1880, 777 tons of fish were destroyed as being unfit for human food, and he attributes this loss in a great degree to the defective state of Billingsgate Market. Two-thirds of the fish that reaches the London market,

about 90,000 tons, are brought by train. As all of this fish has to be carted through the streets of London to Billingsgate, and then brought back again to the West End and distributed over a radius of 7 or 8 miles, it is not surprising that the proportion of condemned fish arriving by train is far higher than that brought by water. Of the 777 tons of fish I have mentioned as condemned, 615 tons were brought to London by train, as against 162 tons by water. This affords conclusive evidence of the necessity of a commodious fishmarket in one of the sites recommended by the engineer and architect of the metropolitan board of works in the immediate neighborhood of the termini of the great railways on the north side of London. So long as London was supplied with fish by water transit, Billingsgate might have sufficed; but now that two-thirds of the fish are brought by train, it is ridiculous to carry such a perishable article as fish through crowded thoroughfares where, according to Mr. Walpole, "the risk of the fish going bad is increased by the delays, constantly extending for hours, and occasionally extending over days, which are due to the inadequate approaches and want of room outside Billingsgate." Let Billingsgate remain as the market for water-borne fish, but let us have another market in the immediate vicinity of where the greater proportion of fish reaches the metropolis.

What is termed fish offal is in this district, I believe, usually sold at 1s. to 1s. 6d. a barrel for manure to the farmers, and by them very much prized; but the question arises, and it is one of some consequence to the fishermen and curers, are you making the best use of this offal? We know that isinglass, medicinal oil, glue, and guano can be made from parts of what are termed offal. Specimens of isinglass of the finest qualities from Nova Scotia were shown at the Edinburgh Exhibition. The utilization of fish offal is attracting considerable attention in Norway, and a grant was voted last year by the Norwegian Parliament to Mr. Sahlstorm, C. E., to carry on experiments in the utilization of fish offal. Mr. Sahlstorm is, I believe, the patentee of an invention for utilizing every portion of a fish. The flesh is converted into extract of fish, the liver into oil, the bones into isinglass, the heads into guano, and the skin into leather. Probably Norway, particularly at such places as the Loffoden Islands (an interesting account of the fisheries of which, and of the manufacture of cod-liver oil, is given in Du Chaillu's "Land of the Midnight Sun"), affords a better field for the particular industry I am referring to. But with better means of fishing I believe the fisheries off the Shetland Islands might be turned to more profitable account.

The first essay for which £100 is offered relates to the natural history of commercial sea-fishes. We require to know more about the food of sea-fishes, also at what age these fish become reproductive, and what localities particular fish frequent at different seasons of the year. A knowledge of these matters would be of great assistance to fishermen. Another essay is on the "Relation of the State to Fishermen and

Fisheries," including all matters relating to their protection and regulation. This would deal with home legislation, lights to be carried by fishing-boats, &c.; regulations for trawlers would also be included. The fishermen have gone so far as to propose to petition Parliament to abolish trawling altogether. Mr. Barclay, in addressing his constituents at Broughty Ferry, has showed that London and our other large towns were mainly dependent on the trawlers for supplies of fresh fish. He says that in London nine-tenths of the fish were trawled, but since 1866 the trawlers have gone on increasing in number, and the proportion of trawled fish that finds its way to the market must be still greater than that referred to by the commissioners. Most of the trawlers now use steam, and the direction we appear to be moving in is the greater application of steam power to all branches of our fishery industry. There is an important consideration which seems to have escaped the attention of those who advocate the abolition of trawling. They seem to overlook the fact that any regulations made by our Government are only binding within territorial waters, *i. e.*, within 3 miles of the shore. Supposing trawling abolished, or a close time for trawlers established, without an international convention the law could only be put in force against our own fishermen. This would simply be an inducement to Frenchmen, Dutchmen, and Norwegians to come and fish off our coast 3 miles from the land, and supply fish to London and other large towns after our own fishermen had been driven from the ground. At the same time I am decidedly of opinion that trawling should be carried on in a manner as little hurtful as possible to drift and line fishermen. The sea fisheries act of 1868, which was passed after we had entered into a convention with France, making the act binding on both nations, provides, "Trawl boats shall not commence fishing at a less distance than 3 miles from any boat fishing with drift-nets. If trawl boats have already shot their nets they must not come nearer to boats fishing with drift-nets than the distance above mentioned." Clause XIII. of the act protects line fishermen, as it is deemed an offense against the act if any one causes damage to the property of another sea-fishing boat. In 1881 another act was passed, entitled the "Clam and bait beds act." This gives the board of trade power, by provisional orders, to protect bait beds (within 3 miles of the shore) from injury by beam trawls. The order may be obtained on the application of the fishermen through a justice of the peace, a town council, or a rural sanitary authority. But there is another charge brought against trawlers; it is said they injure the fisheries by capturing immature fish, and that they destroy the spawn of fish. On this point the sea fisheries commissioners speak very decidedly. They say: "There is no evidence to show that trawling has permanently diminished the supply of fish from any trawling ground, but that there is proof to the contrary," and "we have sought in vain for any proof that the trawl brings up and destroys the spawn of fish." Another suggestion is that the mesh of the net used by trawl

ers should be larger, so as to allow immature fish to escape. This, like other regulations which apply to the open sea, could only be carried out by an international convention.

Money properly laid out in harbors should come under the head of reproductive expenditure. Take the case of Fraserburgh, £100,000 was borrowed at $3\frac{1}{4}$ per cent. In ten years the number of boats fishing from Fraserburgh was doubled, while in the same time the harbor revenue and the value of the exports were nearly trebled. If this is not reproductive expenditure, I fail to understand the meaning of the term; but at the present time it is impossible to obtain money on the terms that Fraserburgh borrowed it. Now, the committee invite essays to inquire into the reasons which have led the loan commissioners to raise the terms on which the money is lent for harbor improvements. Between the years 1861 and 1880—that is, from the date of the harbor and passing-tolls act till December, 1880—the public works loan commissioners lent for harbor purposes £2,781,820. During that period the losses, including principal and interest, only amounted to £16,434 and there is no single case given in the parliamentary return I am quoting from, where there has been any loss on money borrowed for Scotch harbor improvements. I am not saying there has been no loss to the revenue from money spent on Scotch harbors, but the losses—and they are comparatively insignificant when contrasted with those that have taken place in other parts of the Kingdom—have been in instances where special grants have been made, and not in those cases where the people have taken the initiative and borrowed money on harbor dues from the loan commissioners. I think inquiry into this matter will show that the commissioners have raised the rate of interest, in consequence of injudicious loans for other than harbor purposes. Hence the object of the harbor and passing-tolls act of 1861 has been defeated by Sir Stafford Northcote's act of 1879, and I think those interested have a right to ask that the borrowing powers conferred by the act of 1861 be restored to them. I attach importance to this, because I think it is by supplementing local efforts by money lent at the lowest possible rate of interest, that the Government can best encourage harbor improvements. The amount at the disposal of the fishery board, including £3,000 surplus brand money, given for the first time this year on the recommendation of the committee I had the honor of presiding over, only amounts to £6,000 annually. This money is at present being spent in the neighboring harbor of Findochtie, from the construction of which I hope you may derive some benefit. Another source from which we may look for some assistance in the construction of harbors is the employment of convict labor.

Very interesting experiments have been carried on at Peterhead and Aberdeen by pouring oil on the troubled waters at the entrances to the harbors. I have been able merely to read the accounts of those experiments, but they have excited considerable interest in the localities, and

Mr. Shields, the enterprising gentleman who has so energetically taken up this matter, will, I hope, be able to give us the result of his experience in the form of an essay.

An essay for which £25 is offered, is on the best means of increasing the supply of mussels and other mollusks (oysters excepted), used either for bait or food. Each individual fisherman in this district requires two tons of mussels annually for bait. Considering the importance fishermen attach to the easy supply of mussels, it is surprising that greater efforts have not been made to attain it. I have suggested, on previous occasions when speaking on this subject, that the Crown should buy up all the right of mussel proprietors where these rights exist. I believe in some cases they are claimed on very doubtful grounds. That mussel beds so acquired should be placed under the control of the fishery board, and let out to the fishermen. I believe a great deal might be done to increase the supply of mussels. To those who wish to read an interesting account of a mussel farm, I commend that given of the one at Aiguillon, by Mr. Bertram, in his interesting and valuable work, "The Harvest of the Sea."

Is there any ground for the statement we sometimes hear that the sea is being overfished? I believe investigation will prove that there is no cause for alarm. Although no doubt it can be shown that inland firths, and in some districts the sea near our coasts, are not so productive as formerly, yet in the open sea I believe it can be proved that our constant fishing has had no appreciable effect in diminishing the number of fish in the sea. By the railway returns it is shown that in the fourteen years between 1864 and 1878 we have increased by 50,000 tons annually the fish sent inland, while the herring fishing in 1880 was 73 per cent more productive than the average of the last ten years. With these facts before us, I should be sorry to see any attempt to put restriction on fishing by legislation, which it would be extremely difficult to enforce; and if Professor Huxley's calculation, that we do not by fishing take 5 per cent of the herring that are annually destroyed, is correct, I think we may leave the herring in full enjoyment of "home rule," and make no attempt to force any of our legislation upon them at present.

The power and influence of Great Britain depend on her naval supremacy. History teaches us that naval supremacy depends on a hardy and energetic seafaring population. It matters not how rich or powerful a nation may be, or how many ships she can put on the ocean, without seamen to man them she is powerless. What could the Spanish Armada, with all its ships, and soldiers, and sea-sick grandees, do against the little navy of Queen Elizabeth, skilfully handled by Drake and Hawkins, and manned by the hardy fishermen of Devon and Cornwall? It was the naval power of this country that subdued the First Napoleon; but, however great may have been the victories of Nelson, these victories would never have been achieved had he not commanded

real seamen. But although it is our navy that has given us security on the ocean, it is not alone to our men-of-war's men that our maritime supremacy is due. The mercantile marine of the Empire is represented by 8,500,000 tons of shipping. The whole of the rest of the world together has less than 13,000,000 tons. Our gigantic fleet of merchantmen conducts the most enormous commerce the world has ever known, having entered and cleared cargoes at ports in the United Kingdom from foreign countries and British possessions in 1880 of nearly 36,000,000 tons, the foreign trade to this country during the same period being represented by less than 14,000,000 tons. It was the power of our magnificent merchant fleet that enabled us, without disturbing our commerce, to transport in little over three weeks 46,000 men and 17,000 horses to the shores of Egypt, not the least remarkable part of our recent brilliant campaign. But if the maritime power of Great Britain excites the admiration rather than the jealousy of foreign nations, it is because that power has been exerted in the cause of freedom and in the cause of civilization. Our navy suppressed the slave trade; our merchantmen are the pioneers of commerce. Long may we continue to enjoy our strength and to exert it for noble purposes! But let us ever remember that the fisheries along our coast are the cradle of our seamen, the origin of our strength, and the source from which that strength is largely drawn.

VIII.—REVIEW OF THE WHALE FISHERY FOR 1882 AND 1883.

COMPILED BY CHAS. W. SMILEY.

[From the Whalemens's Shipping List, and Merchants' Transcript.]

THIRTY-NINTH ANNUAL REVIEW OF THE WHALE-FISHERY OF THE UNITED STATES.—The year 1882 passed away without any features of special note. Several vessels were lost at sea, mostly in different localities. The only loss of life was that of the officers and crew of the schooner *Pilot's Bride*, of New London. At home, the continued low price of sperm oil has discouraged those engaged in that branch of the business, and is fast leading to its discontinuance.

The present whaling fleet numbers 147, against 161 a year ago, of which number 105 are now at sea. Many of those in port are to be withdrawn for merchant service, while others have become too dilapidated to warrant repairs.

Sperm whaling during the past year has continued to droop, only 8 vessels having taken more than 500 barrels each, of which 4 cruised on the coast of Chili, and 4 in other localities. The owners, tired of small catches and ridiculously low prices, are changing their vessels to right-whaling or withdrawing them from the business. Indications point to an import of 20,000 barrels for the present year, and a probable reduction in the future. As the oil cannot be produced at a less cost than \$1.25 per gallon, we cannot blame our merchants for transferring their time and capital to other enterprises.

Right-whaling has been prosecuted with fair success. Thirty vessels cruised in the Northern Pacific, averaging to each 767 barrels of oil and 11,730 pounds of whalebone, in addition to which they took on their between-season cruises an aggregate of 2,800 barrels of sperm, 750 barrels of whale oil, and 4,000 pounds of whalebone.

Two vessels were lost in the Arctic Ocean during the early part of the season by being crushed in the ice. If bad weather had not unexpectedly prevailed during the latter part of the season, the catch would have been much larger. Many additions are to be made to the fleet the coming year.

The southern right-whalers were fortunate, and fair catches were made on the Tristan grounds and other localities.

The consumption of different products is an interesting subject, and one that requires some attention. It has always been the custom to report as the consumption for the year, the amounts cleared from import markets by the refiners and manufacturers, regardless of the stocks the

latter were carrying at the close of the year. In accordance with this custom the report for the year 1881 showed a consumption of sperm oil in this country of 25,275 barrels, and in England of 3,000 tons, or 30,000 barrels, an aggregate of 55,000 barrels, when actually the large stocks in refiners' hands a year ago makes it probable that the actual consumption was not much in excess of 40,000 barrels.

Below is a carefully made statement of the estimated actual consumption for 1882:

	Barrels.
Crude sperm oil in importers' hands January 1, 1882.....	16,275
Crude sperm oil in refiners' hands in United States and England.....	16,300
Crude sperm oil imported into United States in 1882.....	29,875
Crude sperm oil imported into England from the colonies, &c	3,850
	<hr/> 66,300
Less stock in importers' hands January 1, 1883.....	20,100
Less stock in refiners' hands in United States, and importers' and refiners' hands in England.....	6,000
	<hr/> 26,100
Net consumption for the year.....	40,200

Whale oil is rapidly absorbed as soon as it arrives in market, and whalebone has been used during the past year to a greater extent than heretofore.

Sperm oil, from 95 cents at the commencement of the year, advanced steadily to \$1.05 in February, \$1.10 in April, \$1.11 in July, and then gradually receded, touching 96 cents at the close of the year.

Whale oil from 53 cents in January, gradually advanced, touching 59 cents in September, and declining in December to 55 cents.

Whalebone opened the year at \$1.40 and steadily advanced, touching \$2.25 in October, and closing the year at \$2.

The import of sperm oil for the year 1883 is estimated at 20,000 barrels, but that of whale oil or whalebone cannot be predicted, it being dependent on the success of the Arctic fleet.

The quantity of sperm oil at present on board the whaling fleet is 5,300 barrels, against 12,000 barrels a year ago, being the smallest amount known.

FORTIETH ANNUAL REVIEW OF THE WHALE-FISHERY OF THE UNITED STATES.—The year 1883 has been one of loss to those engaged in this business, and its results have been discouraging. The failure of the Arctic season, with small catches in other localities, has brought but small remuneration to those who risk their capital in the whale-fishery.

The fleet now numbers 125 vessels of all classes hailing from Atlantic ports, against 138 a year ago, and 19 from San Francisco, as against 8 last year. The number of vessels engaged in sperm whaling has been considerably decreased owing to the low prices of oil, while, on account of the value of whalebone, agents are inclined to send most of their ves-

sels to the Arctic Ocean and other right-whale regions. Indications point to a steady decrease in the number of vessels sailing from Atlantic ports, and perhaps a small increase in the number sailing from San Francisco for the Arctic Ocean.

A new feature of the past year, arising from the increase of Arctic whaling at San Francisco, has been the establishment of extensive works at that place for the manufacture and sale of whale and sperm oil, thus enabling the owners there located, as well as others who import oils at that place, to find a market without paying the heavy cost of shipping the same to the Atlantic sea-board. It is understood that the whole Arctic catch of oil, about 10,000 barrels, has been purchased at San Francisco at increased prices. Their works, in addition to large facilities for the manufacture of sperm candles, have a capacity of 150 barrels of oil per day, and are to be enlarged if the imports at that place and the sales of their products shall warrant.

Sperm whaling continues to decline, and no catches of any amount were made during the year except a few in the Atlantic Ocean and two or three off Patagonia. The number of ships and barks now in that fishery at sea is 48, most of which will follow right-whaling during half of the year. The continued low price of oil will soon prevent the business being followed to any great extent.

Right-whaling has been unfortunate, and the season in the North Pacific, owing to prevalence of ice and bad weather, was a failure. Thirty-eight vessels cruised there, 3 of which were lost, and the remaining 35 averaged 274 barrels of oil and 4,350 pounds of whalebone to each. The southern right-whalers were not as fortunate as in the previous year, and their general success was moderate.

The price of sperm oil, from 96 cents up per gallon on January 1st, rose to \$1.05 in April and May, and from that time steadily declined, closing the year at 90 cents.

Whale oil, from 55 cents in January, continued at about the same price, with the exception of a rise to 59½ cents in April, until December, when, on account of the demand at San Francisco, it advanced, closing the year at 60 cents per gallon asked.

Whalebone opened the year at \$2 per pound for Arctic, and, with a few variations, steadily advanced, until at the close of the year it sold at \$4.75 per pound.

The purchases of sperm oil for consumption during the year have amounted to 32,200 barrels; the purchases of whale oil to 23,600 barrels, and of whalebone 376,000 pounds, all the above being bought at Atlantic ports, besides the purchases at San Francisco of all their importations, and quite an amount of oil and bone belonging to New Bedford vessels.

The import of sperm oil for 1884 is estimated at 18,000 to 19,000 barrels, but that of whale oil and whalebone must depend, as heretofore, on the success of the Arctic whaling fleet.

The figures of imports for 1883 do not include the oil and bone purchased at San Francisco, it being difficult at this distance to obtain the information with accuracy.

TABLE I.—*Importations of sperm oil, whale oil, and whalebone into the United States in 1882.*

	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
New Bedford.....	21, 276	16, 236	242, 099
Boston.....	300	20	
Provincetown.....	1, 786	899	
Edgartown.....	153	8	
New York.....	6, 081	6, 168	29, 900
Portland.....	288	10	
Salem.....		30	
Total.....	29, 884	23, 371	271, 999

TABLE II.—*Stocks of oil and whalebone in the United States January 1, 1883.*

	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
New Bedford.....	19, 420	3, 675	170, 000
Provincetown.....	600		
New York.....	80		
Total.....	20, 100	3, 675	170, 000

TABLE III.—*Importations of sperm oil, whale oil, and whalebone into the United States in 1883.*

	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
New Bedford.....	17, 403	12, 272	107, 237
Boston.....	505		
Provincetown.....	1, 431	427	
Edgartown.....	1, 247		
New London.....		841	3, 350
New York.....	4, 009	10, 630	143, 450
Total.....	24, 595	24, 170	254, 037

TABLE IV.—*Monthly statement of imports of sperm oil, whale oil, and whalebone in 1882.*

	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
January.....	1, 526	3, 250	18, 300
March.....	97		
April.....	607	7, 662	1, 523
May.....	4, 723	3, 777	15, 168
June.....	1, 850	626	
July.....	2, 336	186	4, 220
August.....	1, 692	916	3, 300
September.....	5, 902	1, 123	
October.....	4, 492	1, 655	45, 067
November.....	3, 466	1, 233	
December.....	3, 193	2, 943	184, 421
Total.....	29, 884	23, 371	271, 999

TABLE V.—*Monthly statement of imports of sperm oil, whale oil, and whalebone in 1883.*

	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
January.....	1,243	2,660	134,387
February.....	733		
April.....	963	4,680	10,086
May.....	2,256	7,554	5,860
June.....	1,204	149	
July.....	2,856	908	2,851
August.....	517	553	18,115
September.....	2,851	2,960	12,903
October.....	9,853	3,283	3,845
November.....	76	1,083	
December.....	2,043	340	65,990
Total.....	24,595	24,170	254,037

TABLE VI.—*Number of vessels employed in the whale-fishery January 1, 1884.*

	Ships and barks.	Brigs.	Schoon- ers.	Tons.
New Bedford.....	77	3	13	22,877
Marion.....			1	80
District of New Bedford.....	77	3	14	22,957
Edgartown.....	3	1	3	1,297
Provincetown.....		1	11	1,119
Boston.....	1	1	2	691
New London.....			6	812
Stonington.....			2	140
San Francisco.....	17	1	1	6,103
Total January 1, 1884.....	98	7	39	33,119

TABLE VII.—*Imports from 1853 to 1883, inclusive.*

Imports of—	Sperm.	Whale.	Bone.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
1883.....	24,595	24,170	254,037
1882.....	29,884	23,371	271,999
1881.....	30,598	31,677	368,322
1880.....	37,614	34,776	464,028
1879.....	41,308	23,334	286,280
1878.....	43,508	33,778	207,259
1877.....	41,119	27,191	160,220
1876.....	39,811	33,010	150,628
1875.....	42,617	34,594	372,303
1874.....	32,203	37,782	345,560
1873.....	42,053	40,014	206,396
1872.....	45,201	31,075	193,793
1871.....	41,534	75,152	600,655
1870.....	55,183	72,691	708,365
1869.....	47,936	85,011	603,606
1868.....	47,174	65,575	900,850
1867.....	43,433	89,289	1,001,397
1866.....	36,663	74,302	920,375
1865.....	33,242	76,238	619,350
1864.....	64,372	71,863	760,450
1863.....	65,055	62,974	488,750
1862.....	55,641	100,478	763,500
1861.....	68,932	133,717	1,038,450
1860.....	73,708	140,605	1,337,650
1859.....	91,408	190,411	1,923,850
1858.....	81,941	182,223	1,540,600
1857.....	78,440	230,941	2,058,900
1856.....	80,941	197,890	2,592,700
1855.....	52,649	184,015	2,707,500
1854.....	76,696	319,837	3,445,200
1853.....	103,077	260,114	5,652,300

TABLE VIII.—Exports of sperm oil, whale oil, and whalebone from the United States for the last seventeen years.

	Imports of—	Sperm.	Whale.	Bone.
		Barrels.	Barrels.	Pounds.
1883		13,996	4,543	175,614
1882		13,006	4,421	175,470
1881		15,585	6,457	106,049
1880		12,283	4,395	171,258
1879		11,843	7,374	75,715
1878		32,769	14,371	86,787
1877		18,047	6,390	70,850
1876		23,600	10,300	133,400
1875		22,802	5,424	205,436
1874		18,675	3,300	164,553
1873		16,238	2,153	120,545
1872		24,344	1,528	177,932
1871		22,156	18,141	387,199
1870		22,773	9,872	347,918
1869		18,645	3,842	311,605
1868		18,619	9,885	707,882
1867		25,147	18,253	717,796

TABLE IX.—Stock of oil and bone on hand the 1st of January for the last eighteen years.

	Imports of—	Sperm.	Whale.	Bone.
		Barrels.	Barrels.	Pounds.
1884		13,375	4,250	50,000
1883		20,100	3,675	170,000
1782		16,275	6,150	285,000
1881		27,550	12,950	225,000
1880		16,000	6,425	109,000
1879		9,850	15,350	82,000
1878		10,235	8,500	85,000
1877		8,800	8,200	27,400
1876		7,062	8,110	168,800
1875		4,700	10,800	145,000
1874		12,940	20,675	165,800
1873		11,315	16,695	235,300
1872		14,500	30,000	293,600
1871		28,650	36,000	400,000
1870		25,052	41,633	294,900
1869		13,000	16,700	200,000
1868		8,000	33,400	274,000
1867		12,700	21,200	172,000

TABLE X.—Statement of the average prices of sperm and whale oil and whalebone.

	1882.			1883.		
	Sperm.	Whale.	Bone.	Sperm.	Whale.	Bone.
	Barrels.	Barrels.	Pounds.	Barrels.	Barrels.	Pounds.
January	96½	49	1.41½	96	52	1.92
February	1.05	-----	1.38	1.00	53	1.90
March	1.10	50	1.45	1.04	55	2.20
April	-----	50	1.46	1.05	56	2.32
May	1.10	52	1.50	1.05	53	2.43
June	1.10	52	1.52	-----	54	3.25
July	1.10	54	1.63	95	54	3.25
August	1.10	56	1.82½	95	52	3.39
September	1.10	57	2.00	95	55	3.39
October	1.05	58	2.10	92	55	3.00
November	1.03	58½	2.25	92	53	-----
December	98	53	2.00	90	-----	4.43

Average price of sperm oil for 1882, 106 cents.
 Average price of sperm oil for 1883, 97 cents.
 Average price of whale oil for 1882, 53½ cents.

Average price of whale oil for 1883, 54 cents.
 Average price of bone for 1882, \$1.71.
 Average price of bone for 1883, \$2.87.

TABLE XI.—Average price of oil and bone, 1848-1883.

Year.	Sperm.	Whale.	Bone.
1883	\$0 97	\$0 54	\$2 87
1882	1 06	53½	1 71
1881	88	48	1 63
1880	99	51	2 00
1879	84½	39	2 34
1878	91½	44	*2 46
1877	1 13	52	*2 50
1876	1 40½	61	*2 14
1875	1 60½	65½	†1 12½
1874	1 59	60½	1 10
1873	1 48	62	1 08
1872	1 45½	65½	1 28½
1871	1 35	60	†70
1870	1 35½	67½	85
1869	1 78	1 01½	1 24
1868	1 92	82	1 02½
1867	2 23½	73½	1 17½
1866	2 55	1 21	1 37
1865	2 25	1 45	1 71
1864	1 78	1 28	1 80
1863	1 61	95½	1 53
1862	1 42½	59½	82
1861	1 31½	44½	66
1860	1 41½	49½	80½
1859	1 36½	46½	.....
1858	1 21	54	92½
1857	1 28½	73½	96½
1856	1 62	79½	58
1855	1 77	71	45½
1854	1 48½	58½	39½
1853	1 24½	58½	34½
1852	1 23½	68½	50½
1851	1 27½	45½	34½
1850	1 20½	49	34½
1849	1 09	40	31½
1848	1 00½	33	.....

*Currency.

† Gold.

TABLE XII.—Number of vessels and amount of tonnage employed in the whale-fishery since 1850.

Year.	Ships and barks.	Brigs.	Schooners.	Tons.
January 1, 1884	98	7	39	33,119
January 1, 1883	101	8	38	34,137
January 1, 1882	105	10	46	35,892
January 1, 1881	116	11	50	39,426
January 1, 1880	119	11	48	39,433
January 1, 1879	124	12	50	40,602
January 1, 1878	129	11	47	41,197
January 1, 1877	121	8	43	37,828
January 1, 1876	123	7	39	38,883
January 1, 1875	119	8	36	37,733
January 1, 1874	130	7	34	41,191
January 1, 1873	153	12	38	47,996
January 1, 1872	172	12	34	52,701
January 1, 1871	216	18	54	69,372
January 1, 1870	218	22	81	73,137
January 1, 1869	223	25	88	74,512
January 1, 1868	223	17	89	74,596
January 1, 1867	222	10	80	75,340
January 1, 1866	199	8	56	68,535
January 1, 1865	226	7	43	79,696
January 1, 1864	258	5	41	88,785
January 1, 1863	301	10	42	103,146
January 1, 1862	372	10	41	125,462
January 1, 1861	459	14	41	158,745
January 1, 1860	508	19	42	176,848
January 1, 1859	561	19	45	195,119
January 1, 1858	587	18	49	203,141
January 1, 1857	593	22	40	204,202
January 1, 1856	585	21	29	199,149
January 1, 1855	584	20	34	199,846
January 1, 1854	602	28	38	208,399
January 1, 1853	599	30	32	206,286
January 1, 1852	558	27	35	193,990
January 1, 1851	502	24	27	171,971
January 1, 1850	510	20	13	171,484

TABLE XIII.—North Pacific fishery.—Number of American ships engaged in the North Pacific fishery for the last twenty-four years, and the average quantity of oil taken.

Year.	Number of ships.	Average production.	Total.
		<i>Barrels.</i>	
1860	121	518	62, 678
1861	76	724	55, 024
1862	32	610	19, 525
1863	42	857	36, 010
1864	68	522	35, 490
1865	59	617	36, 415
1866	95	598	56, 925
1867	90	640	57, 620
1868	61	708	43, 230
1869	43	890	38, 275
1870	46	1, 069	49, 205
1871	40	.....	15, 000
1872	27	729	19, 680
1873	29	665	19, 300
1874	22	915	20, 120
1875	16	1, 374	21, 980
1876	8	656	5, 250
1877	16	1, 065	17, 030
1878	17	770	13, 080
1879	18	951	17, 118
1880	19	1, 421	27, 000
1881	22	1, 125	24, 740
1882	30	767	23, 025
1883	35	274	9, 605

TABLE XIV.—List of vessels comprising the North Pacific whaling fleet of 1882.

Name of vessel.	Whale.	Bone.	Name of vessel.	Whale.	Bone.
NEW BEDFORD.	<i>Barrels.</i>	<i>Pounds.</i>		<i>Barrels.</i>	<i>Pounds.</i>
Abraham Barker	850	13, 500	Rainbow	1, 000	15, 000
Arnolda	300	3, 000	Reindeer*	350	3, 200
Atlantic	650	11, 000	Sappho † .....	.....	.....
Belvedere	750	9, 000	Stamboul	300	4, 000
Eliza	350	6, 000	Young Phoenix	225	3, 800
Europa*	950	11, 000			
Fleetwing	1, 250	19, 000	EDGARTOWN.		
Gazelle	200	3, 000	Bounding Billow	600	10, 000
George and Susan	900	11, 000			
Helen Mar	800	11, 000	SAN FRANCISCO.		
Hunter	1, 400	25, 590	Bowhead	1, 650	26, 000
Jacob A. Howland	600	9, 000	Coral	1, 000	14, 000
John Howland	1, 750	29, 500	Dawn	900	14, 000
Josephine	300	5, 000	Francis Palmer	350	5, 000
Louisa	400	6, 000	Hidalgo	700	8, 000
Mabel	700	10, 500	Sea Breeze and tender	1, 309	34, 500
Mary and Susan	1, 050	20, 500			
Northern Light	800	11, 500	Total	22, 975	360, 500
North Star .....	.....	.....	
Ohio, 2d	600	8, 000			

* Japan Sea.

† Lost July 8.

‡ Lost May 6.

TABLE XV.—List of vessels comprising the North Pacific whaling fleet of 1883.

Name of vessel.	Whale.	Bone.	Name of vessel.	Whale.	Bone.
NEW BEDFORD.					
	Barrels.	Pounds.		Barrels.	Pounds.
Abraham Barker.....	600	6, 700	Stamboul.....	50	
Arnold.....	100		Young Phoenix.....	300	6, 300
Atlantic.....	125	1, 300	SAN FRANCISCO.		
Belvedere.....	500	8, 000	Amethyst.....	100	1, 500
Europa.....	650	5, 500	Balena.....	100	4, 000
Fleetwing.....	275	3, 900	Bowhead.....	950	15, 000
Gazelle.....	140	5, 900	Bounding Billow.....	240	3, 300
George and Susan.....	250	1, 400	Coral.....	380	3, 000
Helen Mar.....	90	1, 200	Cyane §.....		
Hunter.....	125	4, 400	Dawn.....	100	1, 400
Jacob A. Howland.....	350	2, 000	Eliza.....	375	6, 000
John Howland †.....	250	5, 500	Francis Palmer.....		
Josephine.....	330	5, 000	Hidalgo.....		
Louisa †.....	300	5, 000	Narwhal.....	430	6, 000
Lucretia.....	125	4, 500	Orca.....	1, 300	20, 500
Mabel.....	240	4, 500	Sea Breeze.....	150	1, 800
Mary and Helen.....	380	3, 500	Wanderer.....	125	1, 900
Mary and Susan.....	200	7, 000	Total.....	10, 155	159, 400
Northern Light *.....	325	7, 000			
Ohio, 2d.....	350	7, 000			
Rainbow.....	450	7, 000			
Reindeer *.....	400	3, 500			

* Japan Sea.

† Lost July 17.

‡ Lost September 22.

§ Lost August —.

TABLE XVI.—Stocks of oil and whalebone in the United States January 1, 1884.

	Sperm.	Whale.	Bone.
	Barrels.	Barrels.	Pounds.
New Bedford.....	13, 375	4, 250	50, 000

TABLE XVII.—List of whalers expected to arrive in 1884, with the quantity of oil and bone on board when last heard from.

Name of vessel.	Sperm.	Whale.	Name of vessel.	Sperm.	Whale.
NEW BEDFORD.					
Adelia Chase.....			Kathleen.....		
Adeline Gibbs.....	300		Milton.....	545	300
Alice Knowles.....			Ospray.....		
Alaska.....	410	70	Palmetto.....	650	
Commodore Morris.....			Petrel.....	160	400
Europa.....	150	650	President, 2d.....	460	75
George and Mary.....			Sea Ranger.....		
Golden City.....					

TABLE XVIII.—*Importations for 1882, showing the date of arrival, and the amount of oil and whalebone brought by each vessel.*

Date.		Sperm.	Whale.	Bone.
		<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
1882.				
Jan. 3	Acapulco, New York.....	380	2, 150	11, 000
6	E. Hatton, New York.....	998		
23	Western Texas, New York.....	63		
27	Colon, New York.....	85	1, 100	7, 300
		1, 526	3, 250	18, 300
Mar. 16	City of Para, New York.....	97		
		97		
Apr. 2	Lottie E. Cook, New Bedford.....		133	1, 523
7	Veronica, New Bedford.....	156		
17	Mary S. Ames, New Bedford.....		5, 352	
	Progress, New Bedford.....		1, 418	
	Progress, New Bedford, on freight.....		618	
20	Platina, New Bedford.....	451	141	
		607	7, 662	1, 523
May 1	Sea Fox, New Bedford.....	468		
	Sea Fox, New Bedford, on freight.....	21		
2	State of Texas, New York.....	138		
	L. A. Roby, Salem.....		30	
17	Morning Star, New Bedford.....	124		
	Morning Star, New Bedford, on freight.....	386	416	2, 530
	Lottie Beard, New Bedford.....	1, 849	342	3, 948
23	Wanderer, New Bedford.....	608	680	
26	Sunbeam, New Bedford.....	261	865	690
29	Niger, New Bedford.....	769	1, 159	4, 200
	Niger, New Bedford, on freight.....	99	285	3, 800
		4, 723	3, 777	15, 168
June 5	Ino, New Bedford.....	1, 045	454	
15	City of Para, New York.....	99	39	
25	Colon, New York.....	418	48	
30	Bermuda, New York.....		75	
30	Hyaline, Portland.....	288	10	
		1, 850	626	
July 2	Acapulco, New York.....	230		
13	Veronica, New Bedford.....	380		
16	City of Para, New York.....	40		
24	Colon, New York.....	283		
28	Napoleon, New Bedford.....	1, 175	186	
	Napoleon, New Bedford, on freight.....	228		4, 220
		2, 336	186	4, 220
Aug. 2	Rising Sun, Provincetown.....	211	152	
7	Wave, New Bedford.....	446	2	
	E. Rizzpah, Provincetown.....	218	142	
18	E. H. Hatfield, Edgartown.....	153	8	
21	Agate, Provincetown.....	169	206	
22	Falcon, New Bedford.....	495	406	3, 300
		1, 692	916	3, 300
Sept. 4	M. G. Curren, Provincetown.....	353	168	
13	Ocean, New Bedford.....	612	123	
14	Swallow, New Bedford.....	765	164	
	Admiral Blake, New Bedford.....	148		
15	Acapulco, New York.....		240	
18	Golden City, New Bedford.....	23	26	
20	E. H. Adams, New Bedford.....	84		
21	Quickstep, Provincetown.....	136	3	
22	F. A. Barstow, New Bedford.....	415		
	V. H. Hill, New Bedford.....	205	5	
	Ad. De Ruyter, New Bedford.....	673		
23	James Arnold, New Bedford.....	1, 350	140	
	James Arnold, New Bedford, on freight.....	286	226	
	D. A. Small, Provincetown.....	300		
25	Gay Head, New Bedford.....	79	2	
	Gay Head, New Bedford, on freight.....	74		
26	Antarctic, Provincetown.....	99	26	
27	William A. Grozier, Provincetown.....	300		
		5, 902	1, 123	

TABLE XVIII.—*Importations for 1882, &c.—Continued.*

Date.			Sperm.	Whale.	Bone.
1882.			<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
Oct.	2	San Blas, New York	186	1,013	
	3	General McClellan, New York	506		600
		George and Mary, New Bedford		216	3,414
		William Martin, Boston	210		
	6	S. E. Lewis, Boston	90	20	
	11	Per railroad			41,053
	12	Bloomer, Provincetown		202	
	15	Oronoco, New York	190		
	23	Sarah, New Bedford	716	9	
	29	Veronica, New Bedford	1,961		
	Mermaid, New Bedford	405			
	E. B. Conwell, New Bedford	228	195		
		4,492	1,655	45,067	
Nov.	9	Canton, New Bedford	1,554		
	15	City of Para, New York	1,912	1,233	
			3,466	1,233	
Dec.	4	Stallknecht, New Bedford	2,264	1,130	6,521
	10	Lottie Beard, New Bedford	473	1,543	535
	14	David Crockett, New York	235		
	15	City of Para, New York	75	270	
	26	Acapulco, New York			11,000
	27	Western Texas, New York	146		
		By railroad, New Bedford			166,365
		3,193	2,943	184,421	

TABLE XIX.—*Importations for 1883, showing the date of arrival and the amount of oil and whalebone brought by each vessel.*

Date.		Sperm.	Whale.	Bone.
		Barrels.	Barrels.	Pounds.
1883.				
Jan.	1	Carondelet, New York	196	
	3	San Blas, New York	207	973
		Clara Fletcher, New Bedford	259	
	12	Western Texas, New York	53	
	15	City of Para, New York	277	789
		By railroad, New York		17,000
		By railroad, New Bedford		100,000
	26	Acapulco, New York	159	11,887
	31	Sarah, Boston	92	5,500
		1,243	2,660	134,387
Feb.	8	Veronica	733	
		773		
April	13	C. Adams, New York	199	2,828
	14	Lottie E. Cook, New Bedford		90
		Bertha, New Bedford	274	191
	17	Francis Allyn, New London		485
	26	Alice Knowles, New Bedford	448	987
	27	Bermuda, New York	42	99
		963	4,680	10,086
May	4	Grayhound, New Bedford	111	393
	8	Charter Oak, New Bedford	267	3,953
	24	A. R. Tucker, New Bedford	22	90
	25	John Carver, New Bedford	496	135
	30	Lottie Beard, New Bedford	1,360	983
		2,256	7,554	5,860
June	1	Ruby, New York	198	64
	3	Stafford, New Bedford	390	3
	11	Tropic Bird, New Bedford	25	
	20	E. Kizpah, Provincetown	81	82
	25	Acapulco, New York	428	
	29	Gem, New York	82	
		1,204	149	

TABLE XIX.—*Importations for 1883, &c.—Continued.*

Date.		Sperm.	Whale.	Bone.
		<i>Barrels.</i>	<i>Barrels.</i>	<i>Pounds.</i>
1882.				
July	7 Eliza Adams, New Bedford	1,010	353	1,121
	16 Andrew Hicks, New Bedford	387	22	
	18 Jireh Perry, New Bedford	534	446	1,730
	Veronica, New Bedford	201	35	
	24 William Wilson, New Bedford	179	6	
	27 Antarctic, Provincetown	357	23	
	28 George W. Clyde, New York		23	
	29 Sarah, Boston	188		
		2,856	908	2,851
Aug.	10 Agate, New Bedford	143	243	965
	18 Adelaide, New Bedford		196	
	20 Bloomer, Provincetown	59	92	
	26 Charles W. Morse, New Bedford	315	22	
	By railroad, New Bedford			3,600
	By railroad, New York			13,550
		517	553	18,115
Sept.	1 G. H. Phillips, Provincetown	185	23	
	3 Crown Point, Provincetown	134	131	
	4 Era, New London		119	1,850
	Era, New London, on freight		237	1,500
	7 M. G. Curren, New Bedford	201	292	
	9 Franklin, New Bedford	250	4	
	10 E. Ritzpah, Provincetown	39		
	12 R. Sun, New Bedford	20	225	
	13 Valparaiso, New York		1,440	
	14 Quickstep, Provincetown	172	76	
	Isabella, New Bedford		372	5,000
	Seine, New Bedford	538		
	16 Union, New Bedford	108	35	
	18 S. E. Lewis, Boston	225		
	23 Emma Jane, Edgartown	152		
	24 Railroad, New Bedford			4,553
	26 H. E. Smith, Edgartown	195		
	Alcyone, Provincetown	364		
	27 M. E. Simmons, New Bedford	228	6	
		2,851	2,960	12,903
Oct.	4 A. Bradford, New Bedford		154	2,300
	5 Colon, New York	1,060		
	8 Seina, New York	222		
	10 Young America, New York	118		
	14 Moro Castle, New Bedford	2,438	619	1,545
	15 Pedro Varela, New Bedford	306	2	
	City of Para, New York	95	1,124	
	18 Veronica, New Bedford	2,166	75	
	Mary Frazier, Edgartown	900		
	25 Crescent City, New York	232	550	
	26 Acapulco, New York	70	750	
	General McClellan, New York	295		
	27 Sarah, New Bedford	1,974		
		9,853	3,283	3,845
Nov.	3 Colon, New York	38	358	
	15 City of Para, New York	38	725	
		76	1,083	
Dec.	15 City of Para, New York	133		
	By railroad, New York			7,400
	18 Lottie Beard, New Bedford	1,910	349	
	By railroad, New Bedford			58,590
		2,043	340	65,990

IX.—SVEND FOYN'S WHALING ESTABLISHMENT.*

In the remote northeastern part of our continent, where the White Sea and the Polar Sea meet, lies Vadsoe, a miserable little town, with about 1,800 inhabitants, scarcely one-half of whom are civilized Europeans, for upwards of 900 are Laplanders and Finns. The town is divided into two distinct parts, according to the character of the population. It extends for a considerable distance along the coast, and one part consists of dark log-houses covered with turf, such as are frequently seen beyond the arctic circle, while the part inhabited by the Europeans is built up more closely and has a more cheerful look. In strolling through the streets and alleys of Vadsoe we meet with many strange and characteristic figures. Russians, Finns, Laplanders, and Norwegians mingle in the streets; and this mixture of different nationalities gives a peculiar character to the little town. Here is the small Laplander in his gaudy costume and his soft, cat-like walk. The Russian is generally dirty and seedy in his appearance, with a nose indicating deep and frequent potations of strong whiskey, and with his long hair hanging wildly about his forehead; and towering above all the rest, like a lord and master, is the tall and well-made Norwegian, with his blonde hair and Teutonic features.

The most important person in the whole town of Vadsoe—more important even than the mayor—is Svend Foyn, an old whaler; and it is to him and his whaling establishment that I now desire to introduce my readers.

Fish and whales are the principal sources of income in this country, and as all the fisheries are free, every one endeavors to earn his living thereby. This was also the case with Svend Foyn, who in his youth was a simple whaler, and now carries on the whaling business on an extensive scale. His establishment is located on the coast opposite Vadsoe, and occupies a considerable space. The nearer our boat approached it, the more unendurable became the odor arising from it. When we approached Vadsoe by steamer and the establishment was pointed out to us, our attention had been attracted by some large white hills on the shore whose nature we could not understand; now, however, it became clear to us that these hills were whales undergoing the process of manufacture. At a short distance from the establishment a large

* *Svend Foyn's Walfisch-Etablissement*. From the *Deutsche Fischerei-Zeitung*, Vol. VI, Nos. 47 and 48, Stettin, November 20 and 27, 1883. Translated from the German by HERMAN JACOBSON.

object rose from the water, which at first we took to be a small island or rock, although we had passed the region of the innumerable rocky islands which line the northern and western coasts of Norway. When we came nearer we found that it was a large whale, which had been killed only a few hours before. We must confess that the enormous dimensions of this animal exceeded all our expectations. It measured almost 60 feet in length, and was correspondingly thick; its head and tail were under water, and only the body proper, like an oval cut lengthwise, rose from the sea, whose waves were washing it. We rowed entirely around the whale. It was in every sense of the word a monster; for even the largest land animal known, the elephant, seemed a dwarf when compared with it. Firmly anchored, it awaited its fate. We now rowed to the wharf which extends in front of the establishment. On this wharf stood an old man, the master himself, Svend Foyn, as our boatman told us reverently. We landed, but the ascent offered considerable difficulties. The steep stairs had no railing, and were covered to the depth of several inches with mud, which, mixed with fat, had become a compact and slippery mass.

When we had accomplished the dangerous ascent, we were met by Svend Foyn himself. Truly he presented a most remarkable figure. He was a stout, short man, whose body, in spite of his age, showed strength and flexibility. He was clad in wide flowing garments of a blue color, almost giving him the appearance of a ball; under the broad-brimmed black hat there was a head covered with snow-white hair, but with a pair of bright blue eyes revealing great intelligence. The one of our number who was something of a polyglot addressed to him in Danish a request to allow us to visit his establishment. We had first to undergo a long examination. He wanted to know who we were, whence we came, our names, and where we were going. Only after we had told him that the American among our number was a clergyman, that the other two were Germans, one of them a geographer and the other a lawyer, did he consent, but not until we had assured him that we had not been sent by other whalers to study the secrets of his "manufacture." After we had solemnly assured him that this was not our object, he nodded assent, and the audience with the king of whalers had come to an end.

We now took a survey from the bridge. The white hills on our right and left were actually whales which had been skinned. There were at least from six to eight of them, from the fresh whale, perhaps caught only yesterday, to those which had been lying here from eight to fourteen days, and which, having been continually exposed to the rays of the sun, emitted a very strong odor. Some of them measured sixty feet in length, veritable monsters, which, half floating in the water and half drawn ashore, presented a horrible spectacle. Wherever there was any fat they looked white, and where the flesh had been cut they appeared red, in all imaginable shades and colors. The sight was one which required strong nerves. About a dozen workmen were busy with these whales

engaged in various manipulations. Pieces of fat two and three times the length of a man were cut from the large animals and simply thrown into the water (the workmen partly stand on the whales) and drawn ashore with large hooks. Large quantities of whalebone were lying about on the shore, and I would like to have seen the expression of one of our fashionable ladies when viewing this whalebone and thinking of the delicate pieces of the same material in a prepared condition destined to give a slender appearance to her waist. No doubt she would have characterized this sight as simply horrible.

In a large shed the whales are cut to pieces. After all the fat has been removed they are floated to the shed and hoisted up by means of a windlass on an inclined plane. Here the dissecting process begins. The flesh which still remains is cut off to serve as guano, and the bones are taken out and crushed, to become a fertilizer. Prior to this, however, the entrails are removed—the only part which is of no use—tied together with ropes, and laid at anchor in the harbor till a sufficient quantity has accumulated. Then a steamer takes them in tow and sails out into the open Polar Sea, where they are loosened from the steamer and left to serve as delicious food for different fish.

We wandered farther, again on *terra firma*, which, however, was anything but firm. Supporting ourselves with our umbrellas, we slowly slid forward, carefully placing one foot before the other. Woe unto him who fell as he would inevitably be lost. All the roads leading through the establishment, which has almost the appearance of a small town, were completely soaked with train-oil and grease. To “step into train-oil”—a proverbial phrase with us—is here not only possible, but even pardonable. It might happen to any one of our number, for we were literally wading in a mire of dirt and grease.

We first visited the train-oil warehouse, where about 1,000 barrels of train-oil were stowed away; and thence we went to the guano factory. Here all the meat—everything which is not fat—is turned to guano, by being dried and pulverized. The residue of the fat which has been fried out is likewise utilized in this manner. From here we went into the bone-mill, where the bones are crushed to powder; and finally we visited the trying-house, which was one of the principal objects of interest. It is an enormously long building, or rather shed, having a roof to keep out the rain, its floor being below the surface of the ground and resembling a cellar. In this cellar many small fires were burning, which make the ceiling very warm. The entire building forms one large room or hall; on the warm floor lies the fat, cut into innumerable small pieces and piled up to the height of 2 or 3 feet. The whole mass of fat is seething and bubbling, and every now and then a man stirs it with a large shovel and turns it upside down; but the smell! Along one side of the building, whose floor slightly slants in that direction, there runs a trough into which the train-oil flows, and which conducts it to large basins, where it is rectified. More we did not wish, and actually were

not able, to see; for about an hour we had wandered about through all this dirt, grease, and foul odor, and now we had to say *satis superque* (enough and more than enough). We were truly thankful when, after having slid back over all these dangerous ὕγρὰ κέλευθα (watery ways), we sat again in our boat, which took us back to the steamer. To honest Svend Foyn we hereby express our deepfelt gratitude for having given us permission to visit his establishment; we shall not betray any of his secrets, and cheerfully leave him sole possessor of his "filthy lucre;" in spite of the horrible smell he doubtless thinks *non olet* (it smells not).

After we had gone about a hundred paces from the factory we noticed a small steamer, painted green, which was slowly approaching the shore. Its shape was very peculiar; it was small and short, exceedingly dirty and greasy, without masts, and instead of the prow it had a large board shaped like the top of a table. It was one of the vessels which catch whales. Svend Foyn has four of these steamers, which, during all summer, excepting the close season, cruise day and night in the Polar Sea. Their whole arrangement is peculiar in every respect. As we have said, they are not very large, scarcely from 50 to 60 feet long, and have powerful engines, which can propel the steamer at a rapid rate both backward and forward. There is no room for any cargo, only for the engine, for coal, and for the crew, which comprises from 6 to 8 men. It has no masts and prow, and therefore no rigging, and is really nothing but a hull. The board referred to above lies entirely free, so that from it an unobstructed view is obtained both towards the right and the left. On it there is a gun on a movable carriage. It is loaded with a harpoon, whose pointed head protrudes from the mouth of the gun, and to which is attached a long rope, which is wound on a roller.

X.—THE GREAT HERRING FISHERIES CONSIDERED FROM AN ECONOMICAL POINT OF VIEW.*

By AXEL VILHELM LJUNGMAN.

The fame and importance of the great herring-fisheries make them worthy of becoming the subject of scientific treatment from an economic point of view. But as most writers on political economy have not occupied themselves with the sea fisheries, any attempt to say something on the economic significance of these fisheries meets with great difficulty. It is necessary, however, in order to fathom the actual importance of these fisheries. I have therefore gathered some data which may assist the solution of this question, which has hitherto been somewhat neglected.

I must first give some explanations of technical terms and speak of the difference between coast fisheries and high-sea fisheries. These terms are frequently employed, but most persons use them without having a correct idea wherein consists the difference between these two principal methods of fishing.

Coast fisheries may be carried on near the coast or at some distance from it. Their characteristic feature is that the fisherman every day carries the fish he has caught to the port where he lives, and where the fish are sold, either for immediate consumption or for being manufactured into an article of merchandise.

In the high-sea fisheries, which, as the name implies, are invariably carried on at a considerable distance from the coast, the fishermen are compelled to keep the fish on board their vessels for several days, or prepare them out at sea.

It is evident that the difference between these two methods of fishing is of very great importance as regards the quality of the prepared fish. In a small fishing vessel there are not the same facilities for preparing the fish as in a spacious establishment on shore. The owner cannot superintend the preparation on board as well as he can do it at home in his salt-house. The consequence is that the preparation on board a fishing vessel out at sea, especially when a large quantity of fish is

**Om de stora sillfiskena, betraktade från nationalekonomisk synpunkt.* A paper read before the Swedish Economic Society, February 26, 1883. Translated from the Swedish by HERMAN JACOBSON.

to be prepared, will rarely be as careful as on shore, if the herring are brought home in good time. This is the reason why the Scotch fisheries, which are principally coast fisheries, furnish the best herring which are in the market at the present time. Coast fisheries also have the advantage that fewer hands are needed on board the fishing vessel. No large and heavy boats are required, nor is there any necessity for an expensive equipment, and thus greater results are reached with less capital. One of the disadvantages of the coast fisheries is that the fishermen cannot follow the migrations of the fish as well as in the high-sea fisheries, but in most respects the advantage is on the side of the coast fisheries; and, as matters stand at the present time, the high-sea herring-fisheries offer such great difficulties that in many places the idea of introducing them had to be abandoned. This does not, however, prevent the high-sea herring-fisheries from yielding a good income under certain circumstances.

As well-known illustrations of these two different kinds of fisheries, we may mention, among coast fisheries, the Norwegian and Scotch herring-fisheries, and the great Loffenden cod-fisheries; and among high-sea fisheries, the Dutch so-called "great" herring-fisheries, and the Dutch, French, and Swedish bank fisheries in the North Sea. Of late years a new and remarkable form of high-sea fisheries has developed with unusual rapidity, viz, the beam trawl-net fisheries for bottom fish on the large banks in the North Sea, which yields rich results.

Another circumstance which is of importance in this connection is the employment of different fishing apparatus in the service of private capital. Wealthy firms or associations send out entire fishing fleets, and carry on the fisheries with hired men; while, on the other hand, there are fishermen who carry on their business with their own vessels and apparatus. It is evident that the first-mentioned method of carrying on the fisheries, such as the great fisheries proper, which are worked by men who can at any time be discharged by the owners of the vessels, is neither from a social nor an economic point of view so beneficial to the fishing population as those fisheries where the fishermen own their material and carry on their business in an independent manner. The so-called great fisheries can, therefore, in their social aspect, not be compared with those fisheries which are in the service of small capital. On the coast of Bohuslän, for example, the high-sea fisheries are carried on in such a manner that the fishermen own their vessels; and when one of them becomes feeble, he furnishes another man, who, for half the income, carries on the fisheries in his place. The same also takes place in case of death, when the family which is left behind has a part of the income derived from the deceased person's share in the fishing vessel; and an energetic man, even if he owns only half a share, can gradually earn enough to enable him to buy a whole share. The "great" fisheries, on the other hand, especially in England, meet with many obstacles, more particularly of late years, after more liberal laws

have been made, as the owners of vessels find great trouble in getting the necessary crews for their vessels. It has become a common occurrence for the hired fishermen suddenly to leave the vessel. A special commission, which met last year, was informed by a large firm in Yarmouth that the number of desertions from their vessels reached 1,000 in little more than a year. It is also evident that a hired crew cannot take the same interest in the business as men who carry it on on their own account. It is true that recently attempts have been made to improve matters by giving the crew a certain share of the fish in addition to their regular wages. This, of course, is a considerable incentive; but, on the other hand, fishermen, more than most other laborers, are inclined to be independent, and they do not like to subordinate themselves to the strict order and discipline which must be maintained on the vessels of the large fishing fleets, and which, of course, do not prevail to such an extent on the vessels of independent fishermen. In America a better method has been found for managing the business in this respect. There the wealthy firm which owns the vessel places it at the disposal of a set of fishermen, who carry on the fisheries on their own account and receive a certain share of the fish.

The Dutch high-sea fisheries, as is well known, early developed the custom that rich firms or associations should own the fishing vessels and carry on the fisheries with hired men. The Dutch high-sea fisheries have, therefore, from the very beginning, become "great" fisheries. In Holland it has thus always been considered necessary that when a new fishing vessel was fitted out, some suitable person should be selected who could be placed in charge of the expedition. It depends entirely on his ability to maintain discipline and superintend the preparation of the fish whether the enterprise will prove successful. If he cannot do this, the enterprise will not pay. This manner of carrying on the fisheries, however, depends on a good market for the fish, and on the circumstance whether capital can be found which cannot be put to any better use, and whether suitable men can be obtained who will serve on such fishing vessels, for this service is exceedingly trying and anything but pleasant.

As regards the availability of capital for the fishing trade in general, money is usually forthcoming only too quickly, especially at the beginning of a new fishing period, when people imagine there is a rare chance for making much money in a short time. People will hastily invest a large amount of capital in enterprises before they possess a sufficient knowledge of their character. This causes losses, and people become afraid to invest any more, and the trade suffers. Capital is probably used to the greatest advantage when it is furnished as a loan to competent and energetic men whose character and experience furnish a sufficient guaranty that the enterprise will pay.

The "great" fisheries in the service of vast capital are exclusively carried on by cities, as they alone can start and carry on such enter-

prises with any hope of success. Also, for the fishing trade in general, cities offer great and important advantages, for, in the first place, it will be easier in a place having a population of from 8,000 to 10,000 or more to unite men in measures for advancing the fishing trade than in a village where, even if the population be as large, it is scattered along a great extent of coast. Cities, moreover, possess greater facilities in the matter of postal and telegraph service, better means of communication, and thereby a better chance for disposing of the products of their fisheries. Another great advantage offered by cities are banks. The great herring fisheries depend to a great extent on the circumstance that the manufacturers of prepared fish have access to banks to manage their financial transactions. They need some one to advance to them considerable capital, and the banks can do this. Thus, in Scotland a considerable portion of the fish are paid for, by way of an advance of capital, almost a year before they are ready for the market. Money is also needed for buying material, for paying wages, for paying insurance, &c.; and when the sale of fish takes place these banks attend to the collecting of the money. In Scotland, previous to recent changes, sales were to a great extent made in such a manner that, after the herring were shipped, the sender, by surrendering bills over the crown-stamped herring, the insurance, and the freight, through the local bank, drew a check on a London bank where the buyer had credit, and in that manner got his money immediately. This manner of effecting sales made it common for bankers to loan money on crown-stamped herring which were consigned to some continental port, and this had the great advantage for the Scotch herring-fisheries that they could quickly exchange their fish for money, which otherwise would not have been possible. A bank transacting such business, of course, besides its fees, has the advantage that the savings are placed in it, and the fishermen find this more advantageous to themselves than to place the money in small quantities here and there, as is often done on the coast of Sweden.

In Bohuslän the scattering of the fishing trade, which dates far back, has been the principal reason why the well-being of the population has declined whenever a herring-fishery period came to a close, of which we have a sad example from the year 1809, when the last herring period ended. The population of a city will always find it easier in such a crisis to turn to some other business. This becomes very evident when we examine the state of affairs prevailing in Norway. There, too, the herring have at different periods ceased to come, but as the fishing trade was concentrated in cities like Bergen. Stavanger, &c., the population found it easy to turn to some other employment, and even to other fisheries. Many of the persons engaged in the fisheries were enabled to work their way into the shipping business; and to this circumstance it is principally owing that Norway at the present time has so large a mercantile marine.

As regards the preparation of the herring, it is particularly important that it should be done in a city, as the different salters of one and the same city act as a check upon each other. If one of them makes a mistake, it becomes known. Such matters cannot be concealed in a city with the same ease as in an isolated establishment on the coast. The places where herring are being prepared are, moreover, often visited by the agents of the herring-dealers, and they are better able to exercise a strict control over the preparation of the herring and their quality in a city than if they are obliged, within a limited period of time, to travel from one salt-house to another along a vast extent of coast. This circumstance has also aided in making the Scotch herring famous, because they are almost exclusively prepared in cities. This was early recognized in Scotland, and during the last century the question was agitated of encouraging the formation of fishing towns by granting large prizes, as the idea prevailed at the time that there was no better way of encouraging the fishing trade than by granting prizes.

It is also evident that the fisheries are carried on to greater advantage by persons who uninterruptedly and exclusively devote themselves thereto than by those whose interest in the fisheries is, so to speak, accidental. When, however, a fishery is secularly periodical, as, for instance, the Bohuslän herring-fisheries and the Norwegian spring-herring fisheries, it may be advantageous if others than professional fishermen take a part in the fisheries. Otherwise they could not be carried on to a sufficient extent during the comparatively short duration of the herring period. The circumstance that others than professional fishermen devote themselves to the fisheries may, however, prove injurious to other trades if these are to a great extent neglected, and if people wish to live entirely by the income from the periodical fisheries. Thus it happened during the great Bohuslän herring-fisheries of the eighteenth century. In a short time people earned what they needed for the whole year, and the consequence was that other, and, on the whole, more important, trades were neglected. It is hardly to be supposed that this will take place to the same extent during the present herring period, for the circumstances are in several respects entirely different, and the time which must be taken from other trades for carrying on the fisheries is not so long as not to leave some time over for these other trades. The inconveniences, as far as Bohuslän is concerned, will probably be great enough to call the attention of the persons concerned thereto. In Scotland the herring fisheries are carried on by the aid of hired men from the interior of the country, who are away from home as long as the fisheries last, but I have been unable to find anything to show that agriculture in Scotland has suffered thereby.

National character has an important influence on the development of the fishing trade. There is a vast difference between the national character as developed in the Netherlands and its flat coasts and on the rocky coasts of Norway and Bohuslän. It would be very hard to

compel a Norwegian or a Swede from the coast of Bohuslän to do the kind of work a Dutchman will do. The national character, therefore, plays a much greater part in the question as to the proper manner of carrying on the fisheries than people hitherto have been inclined to believe. If, for instance, there is the least approach to sport in the manner of carrying on the fisheries, this trade is eagerly sought by the fishermen of such nations whose national character is inclined that way. This was even the case with us at the time when the mackerel-fisheries were principally carried on with hook and line. In America new methods of carrying on the fisheries, suited to a lively national character, have sprung up. One of these methods is to equip a vessel which seeks the schools of fish in the open sea, and with an ingenious apparatus makes a rich haul in a very short time. The difficulty lies in the searching for the schools, and it is therefore an object to get fast-sailing vessels and experienced seamen. While this method of fishing, on account of the change from the search and the fast sailing to the fishing itself, is not near so tiresome as the Dutch so-called "great" fisheries, with their slow manner of fishing with seines; it also pays better and gives the fishermen greater liberty. The greater perfection of the apparatus permits them to make in a comparatively short time the same hauls as the sleepy Dutch way of fishing makes in a week or longer. Even the Scotch method of catching herring must be considered as sport compared with the Dutch fisheries.

It is generally known that our great Bohuslän herring-fisheries, as well as the Norwegian spring-herring fisheries, are secularly periodical, that is, they last at most about half a century, and after that the herring stay away fifty, sixty, or seventy years. The exact time cannot be determined. The various herring periods, both of their presence on and their absence from the coast, will, however, average fifty-six years. Even in the western part of the North Sea, near Scotland, the herring-fisheries are secularly periodical, but not to such an extent as in the eastern part of the North Sea. The circumstance that on the east coast of Scotland the fisheries can be carried on every year, the localities or so-called fishing grounds changing from time to time, has a very considerable influence on the manner of carrying on the fisheries. It is evident that permanent fisheries will favor the development of trades which require that the population should be educated to greater skill in them through a long series of years. But when secular periodical fisheries commence, the object is, of course, to obtain the best possible result with as little exertion as possible in the way of learning how to carry on the fisheries. People are generally found to be but little acquainted with the fisheries. It is generally the rural population which clubs together and gets the material which it deems the most profitable; and with this material they carry on the fisheries as best they can. The fact is that these persons who all of a sudden and without any previous experience engage in the fisheries have nothing

else in view but to make money. As a general rule, they do not have much capital to invest; they therefore want cheap apparatus, and, although in many cases good seamen, they are not particularly inclined to go farther out to sea than is absolutely necessary to attain the object in view. This applies particularly when the fisheries are to be carried on during the dark and stormy season of the year. All this, of course, exercises a considerable influence on the fishing trade, which cannot be changed all of a sudden. If, for instance, in Bohuslän an attempt was to be made to introduce another method of carrying on the fisheries than the one determined by the above-mentioned circumstances, this would take so long a time that the fishery period would come to a close before the change had become generally introduced.

Several decades are but a short period in the matter of producing highly developed forms of trade, and of educating the population to engage in an occupation which requires long practice and experience. It must also be taken for granted if, as is the case at the present time in Bohuslän, the fishing population does not move between the various great fisheries, following the herring in their migrations along the coast, that there is no way of remedying the evil. At the time when Bohuslän, as well as Norway, belonged to Denmark, matters were very different in this respect, and when the fishing period commenced both experienced Danes and Norwegians visited the coast of Bohuslän. In a short time, therefore, we had a fishing population which carried on the fisheries with apparatus which it was accustomed to handle, as nets could also be employed. This cannot be done now, but we must build on whatever foundation we possess. It also became evident in the seventeenth century that when the same kind of nets were used as during the Norwegian time in the sixteenth century, this proved a great hindrance in the way of the development of the fisheries, as it was impossible with such a method to obtain at once great results. It is evident that permanent fisheries cause the fishing population to engage in the same as in their proper occupation, and that thereby they obtain a degree of skill and experience which makes the fisheries more productive and makes them a source of income to a much larger number of persons. But, on the other hand, it is evident that the secular periodical fisheries must confine themselves to such methods as will insure good results with a less numerous and less skilled fishing population. Such methods cause much less trouble at the end of a fishing period, while the number of people left without a regular source of income at the end of a period is much smaller.

It is well known that the great herring-fisheries have played a more important part in former times than they do now. All of us have doubtless heard of the great Skania and Dutch fisheries. It is an old adage in Holland that Amsterdam is built on herring bones, and that it owes to the herring-fisheries its origin and development. The Emperor Charles V is said to have declared that the herring-fisheries

brought greater wealth to the Netherlands than the treasures of America to Spain. It will therefore be interesting to see how this trade first sprung up. In olden times the Dutch fishermen visited foreign coasts and there carried on coast fisheries. Thus, they visited Skania during the twelfth and thirteenth centuries, and Bohuslän during the fourteenth century. They did not, however, devote themselves exclusively to the fisheries, but also to commerce. They brought goods and exchanged them for others, which, on their return, they scattered all over the continent of Europe. This business paid very well, and the result was that the Dutch for some time controlled the greater portion of the commerce of the Baltic and of Scandinavia. Commerce was for a considerable period their principal object in engaging in these fisheries. Later the Dutch carried on fisheries on the coasts of Scotland and Norway, and there the method of fishing was gradually developed which at the present time characterizes the "great" Dutch fisheries. Towards the end of the fourteenth century Willem Beuckelszoon, of Flanders, invented an improved method of salting and packing herring. By using this method the herring could be sent to a greater distance, as they kept much longer.

In the year 1416 large seines were introduced. Formerly only small nets had been used, and near the coast probably mostly stationary nets. From that time the herring-fisheries were carried on more for the sake of the fisheries themselves than for the sake of the commerce created thereby; the fishing trade consequently lost some of its economic importance, but was turned more into fisheries exclusively. The fishing fleets gradually increased to 2,000 vessels, and as each vessel had a crew of 14 men, 28,000 persons were engaged in this trade. It will therefore be seen that it was a very extensive and important trade. From the seventeenth century, however, the fisheries began to decline somewhat, as other nations, especially the English, began to compete with the Dutch in this field. England placed every possible hindrance in the way of the Dutch fishermen, and endeavored to prevent them from fishing near Great Britain. Moreover, the Dutch capitalists and fishermen found it more to their advantage to devote their attention to other fisheries and trades, such as the whale fisheries, and in consequence the herring-fisheries began to decline. During the eighteenth century they decreased to such an extent that they had to be kept alive by artificial means, such as premiums; and this condition of affairs continued during the first half of the nineteenth century; but during the last decades the herring-fisheries have again begun to flourish and have made rapid progress. This improved condition is owing partly to the building of railroads, which greatly facilitate the sale of fish, and partly to other favorable circumstances. The Dutch can now sell large quantities of their herring in Belgium to much greater advantage than formerly. Belgium has during the last few years made great progress in every respect, and consumes a large quantity, especially of smoked

Dutch herring. New methods have also been invented of smoking herring, so as to impart to them a finer flavor, and the smoking can be adapted to the demand of the consumers, thus enabling the herring dealers to get a better price for their goods. People have also begun to use cotton thread for manufacturing nets, and in consequence smaller and lighter vessels can be used, which will carry the same number of or even more nets of the same size as the old and heavy hemp nets.

The well-known Skania-German herring-fisheries, which were so important during the Middle Ages, originated in the same way as the Dutch herring-fisheries, although the Germans aimed more exclusively at controlling the trade. It is well known that in those days large numbers of German merchants visited Skanor and Falsterbo, where many people were wont to congregate, and where a good deal of business was done outside of the herring-fisheries. These were probably the portions of our trade which the Germans desired to control more particularly; and the name "herring fair" was therefore given to the great market which was held in Skanor and Falsterbo. The needs of a laborer in those days were not great, and a comparatively large number of people could make a living even by small fisheries. People in those days lived in such a miserable way that our fishermen would be horrified if they were compelled to live in such a manner.

It is well known that there are several different ways of carrying on the herring-fisheries as to their economic value. These methods of fishing are either adapted to the prevailing economic condition or to the natural conditions of the locality where the fisheries are carried on. It is evident that if the greatest possible advantage is to be derived from the fish visiting the coast, many different methods of fishing should be employed, so as to insure the best results under all circumstances.

The apparatus, as a general rule, employed in the herring-fisheries are nets and seines. With the nets the fish are caught by rushing against the net and sticking in its meshes, while in the seine fisheries a school of fish is surrounded and the fish are drawn on shore alive, or the seine is, especially in the open sea, stretched underneath the school, so the fish are, so to speak, caught in a large bag. If we view these methods of fishing from an economic point of view, we will soon find that the greater the number of different ways in which an apparatus can be employed the better it will be. Thus, it is better if with one and the same kind of net both mackerel and herring can be caught than if only one kind of fish can be caught with it. It is also an advantage if one and the same net will catch fish of different size, and if it can be used in many different waters, so that it is possible to use it near the coast and at some distance from it. It is also evident that the apparatus which can be used in different depths is better than that which can only be used in one certain depth. It must, therefore, be considered a step forward in the fishing trade when nets were constructed in such a manner that they could be let down to a considerable depth, instead

of merely floating near the surface, as was the case formerly. It was another great step forward when a method of setting nets was discovered in Norway whereby herring could be caught at any depth. It is also true, if a fishery must be carried on with nets, that it is better to have several ways of using the nets than merely one, and to use the nets both floating and stationary, as the migrations of the fish require. The same applies to seine fishing. It was thus a great step forward, in an economic sense, when a seine was invented which could be set at any required depth.

Formerly it was customary for the seine to follow the bottom or else the surface. It was another great step forward when the Americans invented a seine which could also be used in the open sea. It is also evident that the longer the period during which an apparatus can be used, the better it will be. The longer a fisherman can use his apparatus and hope to catch enough fish to make it pay, the greater will be the chance for him to pay the interest of the capital and the capital invested in the apparatus. It is, in this respect, of special importance that, if there are fish which visit the coast at different times, the same material can be used to the greatest possible extent all the time. This is the case with the herring-fisheries on the coasts of Great Britain, and also in the Sound, where there are fisheries during the greater portion of the year, although the principal herring-fisheries take place in autumn. It is also evident that the safer an apparatus, the better it will be. Even if a fisherman is ever so courageous, he will always consider it a special advantage if he need not risk the loss of his apparatus. The fear of losing their apparatus is always great among the fishermen, especially when a considerable capital has been invested in them. This shows itself particularly in Scotland when the fishermen go out to sea. As soon as it looks as if a storm was approaching they immediately make for home, and do not venture to expose their apparatus to the dangers of the open sea. Even the danger of losing their lives plays a more important part, both as regards the fisheries and the method employed, than is generally believed. It is also clear that the richer the catch, when compared with the amount of capital invested in the apparatus, the better it will be. In this respect there is considerable difference between different localities. Much depends on the place where the fish are sold, for their value varies greatly in different places.

With regard to the floating-net fisheries near Scotland, during the last ten or twenty years the peculiarity has shown itself that the quantity of nets was increased without a corresponding increase in the average quantity of fish caught by each boat. This caused a Mr. Cleghorn, in 1864, to make a calculation when the Scotch fisheries would come to an end. He prepared a diagram showing the gradual decrease of the number of fish caught, and thereon based his calculation of the time the fisheries would probably last. He arrived at the result that the time was not far distant when these fisheries would no longer yield an in-

come. There is no reason, however, to suppose that such an event will take place, although the undeniable fact that at present a quantity of nets five or six times larger than in former times has to be used proves that the herring are more scattered than formerly. With the increase in the quantity of the nets, the expenses for apparatus have, of course, increased, while the number of trips has been diminished.

It is the general opinion that the fisheries are a trade whose economic value is constantly on the increase. In the same degree as the apparatus is enlarged it costs more money, and the fishermen are therefore compelled in some way or other to get a larger income in order to get the apparatus, which is constantly becoming more expensive. As the average yield of the fisheries per vessel has, on the whole, not increased in the same degree, it has become necessary for the fisherman to provide for the needed increase of his income in some other way. There is no difficulty about this in Scotland, as all the products of the fisheries find a ready market through the numerous railroads. For the Bohuslän people, however, such an increase in the cost of apparatus, without a corresponding increase in the yield of the fisheries, would prove a more serious matter. The great quantity of nets, however, exercises a very considerable influence on the manner in which the fisheries are carried on. People are much more afraid of stormy weather, in spite of the more general use of the barometer, and fishing trips are often made in vain, while at the same time it becomes necessary to make a larger catch on every trip when nets are used, for which reason they also must be larger than formerly. The same remarkable increase has been noticed in the Dutch and French herring-fisheries. Here, too, the number of nets has been increased, so that it is no uncommon thing for a fishing vessel to have several hundred nets. As the hauling in of the nets takes more time, the fishermen have less time to take proper care of their fish, and the very exhaustive work of hauling in the net even causes spitting of blood. Steam is therefore, to a constantly increasing extent, employed in doing this work; but this, of course, causes another increase of expenses and makes it more difficult for small capitalists to take part in the fishing trade by equipping fishing vessels, for experience has shown that joint-stock companies are but rarely calculated to insure a paying income from the "great" fisheries.

As regards the preparation of the fish, it may be said that the fisheries with floating nets in general are more profitable, as thereby the catches are more even though smaller, while with the seine fisheries the catches are often so enormous that it becomes almost impossible to prepare the fish properly. It happens sometimes in the net fisheries, when the herring approach the coast, that a rich haul is made, especially when the herring come very near the coast. This is the reason why the vessels from the southern part of Scotland generally make greater hauls than those from the northern part, owing to the fact that the herring

now prefer the southern portion of the east coast of Scotland, while formerly the case was reversed.

The circumstance that seine fisheries can quickly develop into a trade of very considerable importance, while the net fisheries need a much longer time, is explained by the fact that it requires less capital to start seine fisheries, and that these fisheries are particularly productive. We have thus had instances during a winter that the Bohuslän seine fishers, with apparatus valued at from 2,500 to 3,000 crowns [\$670 to \$804], could, during a comparatively short period, earn from 10,000 to 20,000 crowns [\$2,680 to \$5,360]. It is but natural that the news of such rich profits, which spreads rapidly, should attract people to the fisheries.

If one wishes to judge of the prospects of a fishery he must, of course, take into consideration the quantity of fish which may be counted on in proportion to the equipment, apparatus, and labor, and the average price which may be obtained for the fish. If he desires to calculate this average price, regard should be had principally to the wholesale selling of fish. If, as in Scotland and Bohuslän, the fish must be sold in a salted condition, the price should be taken which salt fish bring in the great ports of the Continent, especially in Stettin and Hamburg, taking, of course, into account the expenses under the heads of customs, freight, insurance, &c., and subtracting the sum from the price paid for the fish. A further reduction will be caused by the necessary expenses for salt, barrels, labor, and the profit always allowed to the persons engaged in the preparation of the fish. No account should be taken of the exceptional prices paid for small quantities of fresh fish which are imported into the ports of sale at times when the supply is small compared with the demand. These exceptional prices are often so high as to exceed by far the prices paid for salt herring. It thus happens, as in Bohuslän, that when the seine fisheries commence in autumn, the demand from German smoke-houses is very great, and that as much as from 25 to 30 crowns [\$6.70 to \$8.04] is paid per barrel of common Bohuslän herring. It is impossible for the Bohuslän salters to pay such prices, and the highest price they can afford is 12 crowns [\$3.21] per barrel. As a general rule, it does not pay to engage in regular fisheries of rare and expensive kinds of fish. Near Yarmouth, however, a kind of herring is caught which comes near to the land, and is therefore called "longshore herring"; of these herring, however, not more than 2,000 barrels are caught per annum. That quantity is considered very good, and it is no uncommon occurrence that the fishermen will get as much as 6 pence apiece for fresh herring of this kind. They are smoked lightly, and are then generally sent to London by express train, where as much as 1 shilling apiece is paid for them. We would, of course, arrive at erroneous results if we were to calculate the entire yield of the great Yarmouth herring-fisheries according to the prices which are paid by the piece for such a rare delicacy. We should also take into consideration the time during which the apparatus can be

otherwise employed, when the vessels can be used for other fisheries, so that an extra income is derived which may aid to pay the interest on the capital invested, and eventually the capital itself.

At all times the question has frequently been discussed whether the herring-fisheries can be furthered by any measures taken by the Government, and as the Dutch fisheries enjoyed the greatest reputation, these measures generally aimed at creating fisheries like the great Dutch herring-fisheries. In Sweden, Axel Oxenstierna endeavored to create large fisheries on the Dutch model. For a long time he carried on negotiations with England for a treaty by which Swedish subjects should be permitted to fish in English waters, and Cromwell finally consented to let 1,000 Swedish vessels fish on the English and Dutch coasts. Gottenburg was granted special privileges as regards the herring-fisheries on the Dutch model. The great herring-fisheries which were aimed at, however, never developed properly. During the eighteenth century a Stockholm firm, A. & J. Arfwedson & Co., was granted the privilege of carrying on herring and cod fisheries in the Dutch manner, and they carried on these fisheries for several years. Vessels were fitted out which every year were engaged in the herring-fisheries, during midsummer near the Shetland Islands, and later in the season near the coast of Bohuslän. But these fisheries gradually gave way to the Bohuslän coast fisheries. This was possibly caused by the circumstance that the herring which during the interval between the herring periods visited the coast of Bohuslän were of an excellent quality. Although they could not in every respect be compared with those caught near the Shetland Islands, they nevertheless were so much like these that the difference in quality was not sufficiently great to justify people in paying the higher price demanded for the Shetland herring. In consequence the coast fisheries injured the Bohuslän high-sea herring-fisheries during the greater portion of the last Bohuslän herring period.

Similar attempts were made in Denmark and Norway without much result. In France the Government, after the loss of her American colonies, made efforts to introduce herring-fisheries on the Dutch model; and by making enormous sacrifices France has succeeded in creating very considerable herring-fisheries in the North Sea and in the Channel. In Germany efforts have also been made to further the development of such fisheries, and by engaging some Dutch fishermen the Germans have succeeded in catching about 5,200 barrels of herring in 1881, and 7,200 barrels in 1882—in truth, a very trifling quantity. In Scotland vigorous efforts were made during the seventeenth and eighteenth centuries to introduce herring-fisheries on the Dutch plan. During the eighteenth century hundreds of thousands of pounds sterling were paid as premiums to persons fitting out vessels and preparing fish on the Dutch plan, but without the desired result, except to show what an incentive premiums are. The whole system has been well characterized by Adam Smith, in his famous work on the “Wealth of Nations,” when

he says that "people engaged in fisheries to catch premiums, and not fish." Later, in the year 1824, Dr. I. MacCulloch, in an excellent treatise on the Scotch herring-fisheries, expressed the wish that the time might never come when it would become necessary in Scotland to have recourse to Dutch fishing methods, and to have high-sea herring-fisheries. People began to see clearly that both from an economic and social point of view these fisheries were much less profitable than the Scotch coast fisheries, which were developed on a national basis. A curious illustration of the fact that these Dutch fisheries were but little worthy of imitation was furnished by the Dutch delegates to the conferences which were held between the Scotch and Dutch about the middle of the sixteenth century, these delegates maintaining that the Scotch could not well carry on such fisheries. They informed the Scotch that these fisheries were so poor that they would never desire to engage in them. This proved true, and in spite of all attempts in this direction, aided by liberal premiums, the Dutch method has not been introduced in Scotland.

When the British Government, in the beginning of the present century, determined to lend more powerful aid to the Scotch herring-fisheries, and to pay premiums for improved methods of preparing herring, these fisheries began to flourish to an extraordinary degree; and the same may be said of the other sea fisheries. The sums appropriated were certainly large, but the results have been astonishing. The care which the Government took to obtain a good market for the Scotch herring developed a trade which, in every respect, is the healthiest fishing trade on record.

In 1881 there were engaged in the herring-fisheries 4,997 vessels, with an average of 30 feet of keel and a total capacity of 79,496 tons; 4,423 vessels, with a length of keel varying from 18 to 30 feet and a capacity of 21,943 tons; and 5,389 vessels, with an average length of keel of about 18 feet and a capacity of 12,720 tons, making a total fishing fleet of 14,809 vessels, with a tonnage of 114,159 and a total crew of 48,121. The Scotch sea fisheries, in addition, give employment to 1,063 salters, 2,398 coopers, and 45,291 other persons, making a total of 96,873 persons. The value of the fishing vessels is £622,452; that of the nets, £663,572; of the other apparatus and material, £112,437; in all, £1,398,461 [about \$6,782,500]. As appears already from these figures, the herring-fisheries are by far the most important fisheries, and by the manner in which they are conducted they give to the Scotch sea fisheries their true character, viz, that of coast-fisheries. The Scotch coast herring-fisheries are at the present time the most extensive herring-fisheries known as to the pecuniary value of the fish caught. A great deal may be learned from the Scotch in this respect. The experience of the Scotch shows that one may be mistaken in making up one's mind beforehand that a certain method of fishing is the right one,

and that the development of the true method may be hindered and made difficult by working to introduce the method which erroneously is supposed to be the best, but that by aiding the sale of fish a trade may be furthered which is not much thought of, and assume dimensions of which no one dreamed. It is evident that if efforts are made to extend the market for fish, which may be done in many different ways, as by taking measures to have a first-class article prepared, and by granting certain privileges to the export trade, the fishermen, who thereby obtain a better price for their goods, find the means to acquire better material and apparatus, and adopt methods of carrying on their trade which became possible only because of the higher prices paid for fish. It is clear that as a general rule it will be impossible to force a trade into existence unless the necessary economic conditions are given. Otherwise the result will be the same as that of the Scotch fisheries after the Dutch manner, artificially fostered by premiums, viz, that the fisheries continue just as long as these premiums are paid, and no longer. It is, moreover, self-evident that if it is impossible to obtain the very best of anything, one should content himself with what he has, and try to make the best of it. Never forget the old legend of Atte, who, after he had got a whole sleigh full of game, chased a squirrel so long that he lost both the sleigh and its contents.

A method of furthering the sale of herring, which from an economic point of view must be considered remarkable, is the so-called "testing of the herring." During the Middle Ages special men were appointed who tested herring and other articles of food. In the north of Germany these men were called *bracker*. They had to testify whether the goods were of the desired quality, and if this was not the case the goods received a certain stamp to show their inferior quality. Later this testing developed into a classifying of the goods, according to their different quality, by different stamps. If such a method of testing is to prove an advantage to the herring-fisheries, it is necessary that it should be done in the country from which the fish are exported, and that it is done in such a manner as to inspire confidence. For this reason the Government of Scotland, in 1809, appointed testers who watched the preparation of the herring during the entire salting season, and after the prepared fish had been examined the barrels were marked with the prescribed crown stamp. This was continued till the year 1859. Already previous to this time some opposition to the testing of fish had made itself felt in Scotland, and the result was that it was resolved that those persons who desired to have their fish tested had to pay a certain fee for it. In spite of the fact that this fee has now to be paid for every barrel of herring which is tested, the number of barrels which are tested and stamped has increased very considerably. During the period 1860-69 the manufacture of salt herring increased 29.6 per cent., while the number of barrels tested and stamped during the same period increased

55 per cent. It has been objected to the testing in Scotland that it was not in conformity with the ideas of modern times, and that it benefited only those salters who were not able properly to superintend the salting, and had therefore to have other persons to do it for them. It is evident that if the tester refuses to impress the crown stamp on a considerable quantity of herring, this shows that the salting has not been properly superintended. Those persons, therefore, who do not personally superintend the salting of their fish derive great benefit from the testing. This testing, moreover, is considered with great favor in the German market. In Germany the testing and stamping is frequently considered such an absolutely sure indication of the good quality of the herring that they are sold from one person to the other without being examined. This is a great advantage, for if the barrels are to be opened merely to examine the quality of the herring, these will often suffer thereby. The testing is also an advantage for the salters. They find it easier to obtain a loan of money if they can show that they export crown-stamped herring. It must also be taken into consideration that the tested and stamped herring fetch a somewhat higher price in the market, and that it is much easier for new beginners in the salting business to get up in the world if they have their herring tested and stamped, for otherwise the large firms would almost make a monopoly of the exportation of herring.

The objections which are raised against the testing of herring are generally these, that it is a violation of the fundamental principles of free trade, and also that thereby the introduction of still more improved methods of preparing herring is prevented. The last-mentioned objection would, to some extent, be true, if the enormous masses of herring which are brought on shore did not make it impossible to have more than one good method of preparing the herring; for all that is required is that the large quantity of herring yielded by rich herring-fisheries shall be prepared so as to present a fine article and find a ready and extensive sale. As I have, in a recent work on the salting and testing of herring, and the herring trade in general, discussed more fully the question of testing, and its advantages and disadvantages, I shall not dwell any longer on this subject.

A method of furthering the fish trade which has been employed of late years, and which has acted somewhat against the method of testing, especially when we take into consideration the possibility for new beginners to work their way, is the holding of fishery exhibitions. It is clear that the prizes which are given at such exhibitions prove of some, though, perhaps, not very great, advantage to those who receive them (those who do not receive any prizes suffering a corresponding disadvantage), without furnishing a guarantee that the articles which have received a prize will be good when brought into the market; for even if the article in after times deteriorates, it will retain under all circum-

stances the distinction gained by the prize. Very frequently the articles placed on exhibition are not at all intended for the market, but are specially prepared for an exposition. Many other objections might be raised against these exhibitions, which, as it seems, are repeated too frequently, and which, though well meant, are of no great practical value.

The herring-fisheries have also been encouraged by putting a heavy import duty on herring, a measure which, of course, can only be advantageously employed in very populous herring-consuming countries, like France and Germany.

XI.—THE NORWEGIAN FISHERIES IN 1883, WITH STATISTICS OF PREVIOUS YEARS.*

The cod fisheries near Spitzbergen proved a complete failure. The Tromsø Fishery Association reports as follows: "This fishery seems to be still more unreliable than the capelan fisheries. Many fishermen believe that we have entered a period, which possibly may last several years, when the cod will stay away entirely from Spitzbergen." Tromsø equipped 10 vessels for the cod fisheries. The other vessels engaged in these fisheries came from the following places: 1 from Trondhjem, 2 from Christiansund, 2 from Aalesund, 1 from Arendal, and 2 from Hammerfest.

THE BANK FISHERIES NEAR AALESUND—(Communicated by Consul M. Hansen).—In the winter fisheries there were engaged 90 Norwegian vessels, with a total crew of 747 men, and the number of fish caught by these vessels was 465,200. Of Swedish vessels there were 25, with a total crew of 250 men; the number of fish caught by these was 161,200.

In the summer fisheries at Storeggen there were engaged 22 vessels, 21 Norwegian and 1 Swedish, with a total crew of 270 men. The following quantity of fish was caught by these vessels: 1,272,000 kilograms ling, 157,000 kilograms torsk, 814 hectoliters liver, and 246 hectoliters roe, the total yield representing a value of 155,548 crowns [about \$41,686.86]. The yield of klip-fish of both fisheries would therefore be about 1,100,000 kilograms.

The winter cod fisheries in the Stavanger district are said to have yielded about 200,000 cod.

The Havbro cod fisheries (fisheries on the banks in the Polar Sea) were carried on by a vessel from Tromsø, as an experiment by the fishery association of that town. The yield amounted only to 3,500 cod. This small quantity, it is said, was principally owing to the lack of fresh bait.

THE ICELAND COD FISHERIES.—From information received by the editor of this journal it appears that 23 vessels from various Norwegian ports were engaged in these fisheries. The total yield was 200,000 cod, the greater portion of which was sold in England. The largest

* "*Norske Fiskerier*, 1883." From *Norsk Fiskeritidende*, Vol. III. Bergen, January, 1884. Translated from the Danish by HERMAN JACOBSON.

catch amounted to 34,000. Seven vessels from Aalesund were engaged in these fisheries, with a total crew of 56 men, their tonnage varying from 21 to 103. The individual shares of the crews varied from 135 to 400 crowns [\$36.18 to \$107.20]. Besides cod there were caught haddock, halibut, wolf-fish, sea-perch, torsk, codfish (some unusually large), and ray. Some fishermen had taken herring nets along and caught a sufficient number of herring for bait and for their own food. From the information received it appears that it took about 1,200 cod for a ton of liver. The fishing season lasted from the middle of June till the beginning of September. Both on the east and west coasts of Iceland the fisheries were occasionally hindered by the ice.

THE FINMARK WHALE FISHERIES.—In East Finmark the following Norwegian vessels were engaged in these fisheries: From Tonsberg, 8 vessels, with 221 men; from Sandefjord, 5 vessels, with 144 men; Laurvig, 1 vessel, with 30 men; Arendal, 1 vessel; Bergen, 1 vessel, with 28 men; Trondhjem, 1 vessel, with 28 men; and Christiania, 3 vessels, with 75 men. The engines on these vessels were generally 30 horsepower, some 15, and a few 40. The above 20 vessels were stationed as follows: 2 in Vadsoe, where there is a guano factory, 3 in Jarfiord, 1 in Pasvig, 1 in Madvig, 2 in Kobholmfiord, 1 in Kiberg, 3 in Svartnæs, 1 in Smelroren, 2 in Syltefiord, 2 in Engelviken, 1 in Stegelnæs, and 1 in Vardoe.

The following was the result of the fisheries: At Vadsoe, 24 whales, or 12 per vessel; in the South Varanger district (Jarfiord, Pasvig, Madvig, and Kobholmfiord), 124 whales, or 18 per vessel; in the Vardoe district (Kiberg, Svartnæs, Smelroren, and Syltefiord), 178 whales, or 26 per vessel; and at the island of Vardoe (Engelviken, Stegenæs, and Vardoe), 72 whales, or 18 per vessel; making a total of 407 whales, or 20 per vessel. Most of the whales are caught 7 or 8 Norwegian miles (about 4.7 English miles each) from the coast. The fisheries commenced in the beginning of April and came to a close about the middle of August. One Russian vessel was engaged in these fisheries, and was stationed in the Mokkafiord. It caught 22 whales. Next year 2 more Russian vessels will be engaged in the whale fisheries.

In West Finmark 3 vessels were engaged in the whale fisheries, all from Tonsberg; 2 of these were stationed at Sorvær and 1 in the Tufiord. The total catch was 99 whales.

The average value of the train-oil is 500 crowns [\$134] per ton, or \$13.40 per keg of 102 kilograms net, from which should be subtracted for freight 3 or 4 crowns [80 cents to \$1.07].

The Finmark whale fisheries owe their origin to M. Svend Foyn, of Tonsberg, who in 1864 made the first attempts near Vardoe and in the Varangerfiord, and continued them in 1865, 1866, and 1867. In 1866 he caught nothing, and in 1867 only one whale, while in 1868 he caught 30. In the following year he sent out 2 vessels, which, however, caught only

17 whales. Later the yield of these fisheries, not counting those whales which were cast ashore, has been as follows:

	Whales.
1870	36
1871	20
1872	40
1873	36
1874	51
1875	37
1876	42
1877	32
1878	130
1879	123
1880	145
1881	279
1882	386
1883	506
In all, since 1866	1,911

In 1877 a new association was formed at Jarfiord, and in 1881 one new establishment was founded in East Finmark, at Vardoe, and two in West Finmark, 2 at Tufiord, and 1 at Sorvær. In 1882 the whale fisheries were carried on by 8 associations, with 12 vessels, which number in 1883 rose to 14 associations, with 23 vessels. There are at present 11 establishments in East Finmark and 3 in West Finmark.

THE SEAL FISHERIES IN THE POLAR SEA.—This fishery yielded 121,072 skins, 48 bottle-noses, 25 bears, 22,140 tons of fat, and 1,800 tons of train-oil, the total value being estimated at 1,900,000 crowns [\$509,200], while the expenses of fitting out were 30,000 crowns [\$8,040] per vessel. The total number of vessels engaged in these fisheries was 16, all of them steamers.

The first Norwegian who engaged in these fisheries, which for a long time had been in the hands of the English, was Svend Foyn, of Tonsberg, who in 1847 fitted out a vessel for the seal fisheries. Till 1852 he sent out only this one vessel, but in that year he sent out 3 vessels; in 1853, 5 (among these 1 from Christiansand); in 1854, 9; and in 1855, 13 (among these one from Sandefiord). During the next five years these fisheries developed gradually, and several others towns sent out vessels. In 1860, 21 Norwegian vessels were engaged in the seal fisheries, viz., 1 from Frederikshald, 1 from Frederikstad, 2 from Drammen (from 1859), 13 from Tonsberg, 1 from Sandefiord, 2 from Laurvig (1857), and 1 from Christiansand. From 1856 to 1858 Holmestrand sent 1 vessel. During the ten years 1861 to 1870 the number of vessels annually engaged in the seal fisheries varied from 15 to 18. In 1866 steamers were employed for the first time, viz., 2 from Tonsberg. It was some time, however, before steamers were more generally employed, for in 1871

their number was only 3. After that year, however, their number increased more rapidly; in 1872 their number was 9 and the number of sailing vessels 14; in 1882 the last sailing vessel was fitted out for these fisheries.

THE SHARK FISHERIES AND THE SPITZBERGEN FISHERIES.—The total number of vessels sent out from Tromsøe was 40, with an average crew of 8 men and an average tonnage of 44. Of these vessels 1 belonged to Christiania, 1 to Arendal, 2 to Stavanger, 1 to Bergen, 1 to Trondhjem, 1 to Helgeland, and 34 to Tromsøe. Four of these vessels did not catch anything. The vessels from Christiania and Arendal took home with them all they caught. The yield of the 34 vessels which brought their catch to Tromsøe was the following:

	Crowns.
211 walrus, at 130 crowns.....	27, 430
5,426 seal, at 16 crowns.....	86, 816
226 whitefish, at 100 crowns.....	22, 600
80 polar bears, at 60 crowns.....	4, 800
265 reindeer, at 10 crowns.....	2, 650
907 kilograms eider-down, at 2.25 crowns.....	2, 041
1,015 hectoliters shark liver, at 21.50 crowns.....	21, 822
Total	168, 159

Of the 40 vessels 23 were stationed near Spitzbergen, 6 near Nova Zembla and in the White Sea, and 11 near Havbroen. Besides these vessels, 2 from Sandefjord and 2 from Aalesund were engaged in the Spitzbergen fisheries, and caught 166 whiting, 190 seals, 3 walrus, 2 polar bears, and besides secured a small quantity of eider-down.

Regarding this year's fisheries (1883), the Tromsøe Fishery Association reports as follows: "In the Murman Sea, or near the entrance to the White Sea, where seal fisheries are going on in May and June, the fisheries were very successful. Near the Kolguev Island an unusually large number of seals were caught. Owing to the favorable condition of the ice near Spitzbergen, which allowed the fishermen to go farther north and east than usual, a larger number of walrus was caught than during any previous year. The violent persecutions to which these animals have been exposed for many years have driven them farther north and east, where they can be caught only in years when there is not too much ice.* The shark fisheries which were carried on along the Tromsøe coast were less successful than usual, while a good many of these fish were caught in the Waranger fiord and near Spitzbergen."

The fisheries near Spitzbergen, principally for walrus, seals, and polar bears, which in former times had been in the hands of the Dutch and later in those of the Russians, were not shared by the Norwegians till the year 1820. Till 1860 Hammerfest was the principal Norwegian port

* The average annual number of walrus caught from 1830 to 1834 was 1,807; in 1876 the number caught was 1,286; in 1878, 621; in 1881, 444; and in 1882, 148.

which equipped vessels for these fisheries, sending out 10 to 15 a year. Later some other Norwegian towns followed the example of Hammerfest, especially Tromsøe. The number of Norwegian vessels engaged in these fisheries during the period from 1866 to 1877 was 45, viz.: 1 from Vardoe, 22 from Hammerfest, and 22 from Tromsøe. During this period the first attempt at fisheries was made near Nova Zembla (in 1867).

Regarding the fisheries in the Polar Sea the following data have been furnished by the Tromsøe Fishery Association:

Fisheries.	Time of sailing.	Time of return.
Seal fisheries in the White Sea	Middle of April....	In the most fortunate case in the beginning of June, but generally in the beginning of August.
Walrus and seal fisheries near Spitzbergen and Nova Zembla.	1st of May.....	In September, sometimes not till October.
Whiting fisheries	15th of May.....	Beginning of September.
Spitzbergen cod fisheries	Middle of June....	Beginning of September.
Shark fisheries.....	1st of April.....	End of September.

During that time 3 or 4 trips are made.

The following data have been furnished relative to the expense of fitting out the vessels and the income from these fisheries:

The outfit of a vessel for the walrus and seal fisheries, with a crew of 10 men, will generally cost about 3,000 crowns [\$804]. To this sum should be added 700 crowns [\$187.60] advanced to the crew, making a total of 3,700 crowns [\$991.60]. The crew generally receives one-third of the gross yield of the fisheries, and this third part is generally subdivided into 4 more parts than there are men. If the crew, for instance, numbers 10, each man receives one-fourteenth of one-third of the entire yield, except the mate, who receives two-fourteenths. The remainder, three-fourteenths, goes to the company. The company provides the entire outfit, including food, and pays the mate 100 crowns [\$26.80] per month, and each harpooner from 60 to 100 crowns [\$16.08 to 26.80]. Each vessel has generally two harpooners.

The outfit of a whiting vessel costs about 1,000 crowns [\$268] more, which increase is principally caused by the seine, which costs about 5,000 crowns [\$1,340], and which, as a general rule, will not last longer than 5 years. The company also pays for the entire outfit, food, &c. As regards the monthly pay and the division of the yield, different rules prevail from those in the walrus and sea fisheries. Each fisherman receives from 20 to 24 crowns [\$5.36 to \$6.43] per month, and the mate about 100 crowns [\$26.80]. If a harpooner accompanies the expedition to catch walrus and seals, he receives from 60 to 100 crowns [\$16.08 to \$26.80] per month. The entire yield of the fisheries (including seals and walrus) is divided into 6 parts, one of which goes to the crew and is divided on the following principle: If, for example, the crew, including the mate, is composed of 10 men, 9 receive one-twelfth of one-sixth of the yield, the mate two-twelfths, and one-twelfth goes to the company.

To equip a vessel for the cod fisheries, if some provision also is made to catch seal, &c., costs about 2,000 crowns [\$536], including salt and ready money advanced to the crew. The yield is divided equally between the crew and the company. The crew pay for their food and their share (one-half) of the salt and provide their own fishing apparatus. Occasionally, however, crews stipulate for having free salt.

In the shark fisheries the equipment for the summer, including the wear and tear of the apparatus, food, and money advanced to the crew, is generally estimated at 2,000 crowns [\$536]. If the company provides food, the crew receives one-third of the yield; while if the crew provide their own food, they receive one-half of the yield.

Both in the cod fisheries and the shark fisheries the mate receives 2 men's shares of the yield, and besides this generally a monthly sum from the company. In all these fisheries the company has the first chance to buy the shares of the crew, at the wholesale market prices. In giving the cost of fitting out vessels for the various fisheries, the insurance premium has not been counted in. The insurance on the Spitzbergen vessels has during the last years amounted to from 5 to 9 per cent of their value.

Whiting fisheries are said to have been carried on with seines at Spitzbergen by the Russians during the period from 1820 to 1830. The Norwegians first commenced to engage in these fisheries in 1867, with 2 vessels, which caught in all 15 fish. In 1868 eight vessels were engaged in these fisheries, and their number increased from year to year till 1872, when it seemed to have reached its greatest height. From that year these fisheries began to decline, and in 1876 only 2 vessels were engaged in them, 1 from Trondhjem and 1 from Tromsøe, the former of which, however, was engaged principally in the cod fisheries. Since then the number of vessels engaged in the whiting fisheries has again risen to 8.

Nova Zembla, owing to the territorial boundary, has much less importance as a fishing station for Norwegian vessels than Spitzbergen. The whiting fisheries near Nova Zembla are for this reason almost exclusively in the hands of the Russians, who during the last year have caught a great many fish. Since 1867 a few Norwegian vessels from Tromsøe and Hammerfest have, as a rule, annually visited Nova Zembla and engaged in the walrus and seal fisheries, and generally with favorable results.

As regards the fishing expeditions sent out from Hammerfest, we have received the following report from Messrs. Feddersen and Nissen, with the remark that, as they possess only very incomplete data, there may possibly be some errors in the figures:

Hammerfest has sent out on the seal and walrus fisheries near Nova Zembla 5 vessels, with a total tonnage of 159 tons and about 50 men, *i. e.*, 10 or 11 for each vessel, *viz.*, the mate, first harpooner, second harpooner, and 7 fishermen. Each vessel has 2 fishing boats with complete

fishing apparatus, and besides these 1 boat for general use. Sometimes the mate also acts as first harpooner. One man is hired to take the mate's place while he is out with the fishing boats. Each fishing boat has a crew of 4 men. While they are out 2 men remain on board, and sometimes 2 men and 1 boy. These 5 vessels have brought back from the coast of Nova Zembla (occasionally they were also engaged in the seal fisheries on the ice, as the seal about that time of the year come from the White Sea), 160 walrus, 2,678 seals of different sizes,* and 3 polar bears, valued at 51,684 crowns [\$13,851.31]. Some of these vessels were very successful in the seal fisheries, but these expeditions to the coast of Nova Zembla have, as a general rule, not been very profitable, especially if—as has been the case during two successive years—they could not enter the Sea of Kara. Last year seal-skins brought a good price, so that the fisheries paid; the oil, however, was offered at too high a figure.

For the Spitzbergen fisheries Hammerfest equipped 7 vessels, with a total tonnage of 209 and a total crew of 70 men, viz., 6 vessels with a crew of 10 or 11 men, and 1 with 7 men, having only one fishing boat. These 7 vessels caught and brought home 230 walrus, 1,108 seals (mostly large), 17 polar bears, 45 reindeer, and 130 kilograms of eider-down, valued at 59,458 crowns [\$16,034.74].

The fishing area is not very large. If many more vessels were to engage in these fisheries, the animals would go farther north into the icy regions, and the entire fisheries would be ruined in a few years.

At the banks in the Polar Sea, principally near the Bear Islands and the south coast of Spitzbergen, shark fisheries were carried on exclusively. Fifteen vessels were engaged in these fisheries, with a total tonnage of 415; 13 had a crew of 6 or 7 men each; and 2, only 5 men. They brought home 2,067 tons of shark-liver, with an estimated value of 51,675 crowns [\$13,848.90]. Two small vessels, with a total tonnage of 35, were engaged in the cod fisheries near the coast of Spitzbergen,† but only caught a few hundred cod.

Whiting fisheries were attempted from Hammerfest, we believe, in 1869 or 1870, by John Berger and a firm in Bergen (probably Mohr & Son), who fitted out a large steamer, with an extraordinarily large and expensive seine; but the enterprise proved an entire failure. In 1872 an expedition for catching whiting was attempted with a sailing vessel, but the results were exceedingly small, and as other attempts made during the following years were equally unsuccessful, no further expeditions were sent out. The expeditions sent out from Tromsøe have been more successful in catching whiting near Spitzbergen; but experience has shown that these expeditions do not pay, as good whiting fisheries are purely accidental and very rare.

* As a general rule, 1 large seal is supposed to yield $1\frac{1}{2}$ tons of fat or 1 ton of oil, and 7 to 10 small seals about 1 ton of fat.

† In all about 700 men from Norway have participated in the various fisheries in the Polar Sea beyond the limits of Norwegian waters.

THE MACKEREL FISHERIES.—(Communicated by Inspector Buch.)—The following table gives the result from those places which made a report :

Districts.	Fishermen.			Yield.				Gross share per fisherman.	Foreign buyers.
	Vessels.	Boats.	Men.	Number.	Value.	Salted and used.	Exported.		
The Jarlsberg and Laurvig districts.	116	....	445	435, 000	<i>Crowns.</i> 87, 000	.....	.....	<i>Crowns.</i> 195	(*)
Lister and Mandal districts. †	329	2	1, 195	2, 497, 400	329, 300	1, 556, 000	941, 300	274	.....
The Stavanger district. ‡	200	70	934	1, 612, 000	217, 800	618, 000	994, 000	220	55
Total	717		2, 574	4, 544, 400	634, 100	.....	.....	246	.....

* 120 boats with 2 men each.

† 2 lives lost.

‡ 3 lives lost.

The average share per fisherman in these three districts was in 1882 198 crowns; and for the whole country in 1881, 200 crowns; in 1880, 187 crowns; in 1879, 202 crowns; and in 1878, 218 crowns.

The Fosen cod fisheries are reported to have yielded in all 1,000,000 cod.

SEINE FISHERIES FOR HERRING.—Besides the fisheries carried on by the regular company, some herring were caught by a vessel of 60 tons and a crew of 4 men, fitted out by Messrs. Lehmkul, of Bergen. This vessel was engaged in the fishery from 10 to 20 miles west of Espvær for three weeks, commencing about the middle of May. In the beginning 1½ to 3 tons of herring were caught per set of seines (18), and towards the end of the month once 7 and another time 8 tons. The herring were of medium size, with little fat, but full of small red crustaceans. In one of these herring, which was examined by the editor of this journal, and which measured 274 millimeters [about 11 inches] in length, the roe measured 92 millimeters [about 3½ inches] in length and 9 in breadth, and weighed 4 grams [about ¼ ounce.]

Mr. Jorgensen, of Hisken, at about the same time made an attempt at herring fisheries between Skudsnæs and the Sæbjorns fiord. The greatest distance from the shore at which these fisheries were carried on was 3 Norwegian miles [= 14 English miles] from Udsire. The catches varied from 100 fish to about half a ton. On account of the clear nights the fisheries came to a close in June, and were not continued later during the season. About 10 to 12 boats engaged in the herring fisheries from Smorstak out toward the Skudsnæs fiord as far as 3 to 5 miles from Hvidnigsoe, but, on the whole, it cannot be said that these fisheries were particularly successful.

During the spring herring fisheries three Dutch cutters made some attempts to catch herring, twice near Lister and twice near Haugesund. The entire yield of each vessel was 5 or 6 tons. These attempts must, therefore, be termed failures; but the cause must probably be sought

rather in the unfavorable condition of the weather and in the selection of unsuitable times and places than in lack of skill and enterprise. About 100 Norwegian boats were engaged in the herring fisheries between Udsire, Rover, and Bommelbaad. The yield varied greatly and cannot be termed very successful.

The attempt made by the Dutch will not be repeated. A Norwegian vessel caught spring herring 14 miles from Egersund as early as December 7. At Hvidnigsoe and Skudesnæs spring herring were for the first time caught on December 24.

The herring fisheries near the Hval Islands came to a close in March, and yielded an estimated quantity of 60,000 tons of salt herring, some of which, however, had been caught by Swedish fishermen. Of this quantity 24,000 tons were salted on board vessels from Haugesund, 3,000 tons on vessels from Stavanger, and 12,000 tons on vessels from Bergen.

On the Norwegian side of the Hval Islands herring were last year caught for the first time on December 14. About the middle of December large schools of herring appeared outside the Laugesund fiord and the Laurvig fiord, and a large number were caught near Nevlunghavn and in the Vig fiord. At the close of the year large masses of herring were observed outside the Flekke fiord. Some specimens, which were sent to the editor of this journal, measured from 317 to 336 millimeters [14 inches] in length and were full of milt and roe, weighing from 40 to 50 grams [nearly 2 ounces].

THE ICELAND HERRING FISHERIES.—Total number of Norwegian vessels engaged, 157; seines, 383; crews, 1,807; yield, in tons, 103,886. Calculating the ton of fresh herring at 8 crowns [\$2.14], and of salt herring at 19 crowns [\$5.09], the total yield of these fisheries would represent the sum of 554,400 crowns [\$148,579.20] and 1,973,834 crowns [\$528,987.51], respectively. At the end of the year 1883, the Norwegians had in all 56 fishing stations in Iceland, each station being composed of a dwelling-house and a warehouse.

THE FAT-HERRING FISHERIES IN THE NORDLAND DISTRICT.—From January 1 till the middle of December tax was paid on 430,300 tons of herring. Some of these belong to 1882 and some were caught in the spring of 1883. These latter were estimated at 40,000 tons. On the other hand, a large quantity of herring had not yet reached the custom-houses, and many are still in the hands of Nordland merchants. The principal fisheries were carried on in October and November, and chiefly in the districts of Bejern, Skjærstad, and Bodo. From places outside the districts of Nordland and Tromsøe 50,000 tons of herring were imported into Bergen alone.

OTHER FISHERIES.—The whale fisheries near Iceland were carried on (besides by the vessels mentioned on page 267 of our last volume) by 1 vessel from Haugesund. Three companies in Haugesund also had shares in Mr. Foyen's establishment in the Lsa fiord.

The shark fisheries near Iceland were carried on by 2 vessels from Haugesund and yielded 175 tons of liver. On the shore of the Isa fiord the merchants of Haugesund have established a steam oil-refinery, where last year 300 tons of oil were manufactured, mostly of the light kind, but no medicinal oil.

As to the whale fisheries near Bergen, at Skagshavn (Sartoroe) 7 whales were caught, and at Florvaag (Askoe) 2.

The coal-fish fisheries in Finmark were very successful, as during the previous year a great quantity were made into klip-fish, probably 2,000,000 kilograms. As a general rule the price of klip-fish made from coal-fish was half that of the klip-fish made from cod.

The salmon fisheries were unusually successful; but the prices were low, as there were also very rich salmon fisheries in Scotland. In Canada, likewise, the salmon fisheries were extraordinarily productive.

The lobster fisheries on the west coast were very successful.

The exports of Norwegian fishery products were as follows, at the end of November, 1883: 10,568,000 kilograms dried fish; 29,616,000 kilograms klip-fish; 6,522,000 kilograms guano; 594,500,000 hectoliters herring; 36,600,000 hectoliters roe; 106,900,000 hectoliters oil.

STATISTICS OF THE NORWEGIAN FISHERIES.

Average annual value of the principal products exported from Norway during the period 1866-1882.

Years.	Products of the forest and wood industries.	Fishery products.	Other Norwegian articles.	Foreign articles again exported from Norway.	In all.	Fishery products.
	<i>Crowns.*</i>	<i>Crowns.</i>	<i>Crowns.</i>	<i>Crowns.</i>	<i>Crowns.</i>	<i>Per cent.</i>
1866-'70	31,000,000	33,300,000	8,200,000	800,000	73,300,000	46.5
1871-'75	44,900,000	41,800,000	16,900,000	2,600,000	106,200,000	39.3
1876-'80	38,800,000	43,100,000	19,100,000	2,300,000	103,400,000	41.7
1881	44,900,000	50,200,000	24,000,000	1,800,000	120,900,000	41.5
1882	45,900,000	47,100,000	26,900,000	3,100,000	123,000,000	38.3

* The crown = 26.8 cents. 1 million crowns = \$268,000.

Exports of guano, 1883.

Custom-houses.	August.	September.	October.
	<i>Kilograms.</i>	<i>Kilograms.</i>	<i>Kilograms.</i>
Aalesund	185,200	21,300	.....
Christiansund	192,800	296,400	85,700
Trondhjem	171,400	.....	2,000
Mosjoen	17,500	.....	.....
Bodo	550,700	50,000	400,000
Hammerfest .....	.....	20,000	.....
Vardoe	10,000	.....	260,000
Vadsoe	150,000	147,700	.....
Total	1,277,600	535,400	747,700
Since January 1.	*4,700,000	5,200,000	5,900,000

* One million kilograms = 2,204,850 pounds.

*Exports of fishery products from 1815-1829.**

Periods of five years.	Klip-fish.	Dried and smoked fish.	Total.	Salt fish in tons, mostly herring.	Roe.	Train-oil.	Lobsters.
	Kilograms.	Kilograms.	Kilograms.	Tons.	Tons.	Tons.	
1815-'19	1,500,000	7,800,000	9,300,000	155,900	8,500	19,200	605,000
1820-'24	3,000,000	10,300,000	13,300,000	307,700	2,000	27,300	927,000
1825-'29	6,000,000	15,600,000	21,600,000	341,000	22,100	40,500	1,280,000

* For the following years, see "*Norsk Fiskeritidende*," 1883, p. 174.

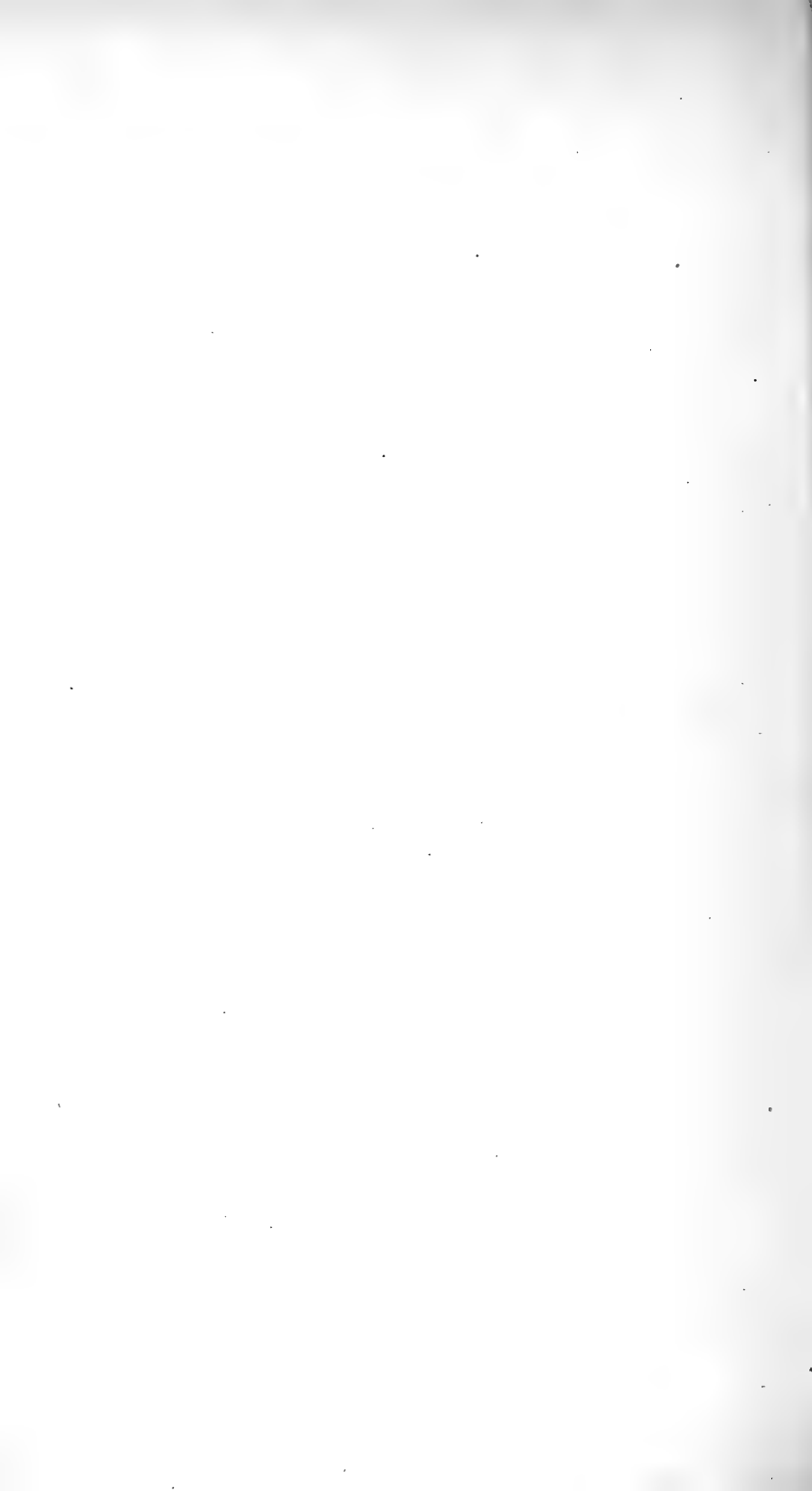
Norwegian exports of fishery products in August, September, and October, 1883.

[Communicated by the Central Statistical Bureau.]

Custom-houses.	Dried fish. (1,000 kilograms.)			Klip-fish. (1,000 kilograms.)			Herring. (1,000 kilograms.)			Roe. (1,000 hectoliters.)*			Train-oil. (1,000 hectoliters.)		
	August.	September.	October.	August.	September.	October.	August.	September.	October.	August.	September.	October.	August.	September.	October.
Frederikshald							0.1	0.6	0.4						
Frederikstad							0.6	1.1	0.1						
Christiania		16	179				1.6	5.5	5.6				0.3	0.5	0.4
Tonsberg							0.1	0.1					5.1	6.0	
Arendal							0.4	0.4	0.2						
Christiansand				2	1										
Flekkefjord							0.1	1.8							
Egersund								1.3							
Sandnes								0.4	0.9						
Stavanger	1	5	3	1	1	3	7.2	23.8	16.3						0.1
Skudenesbavn								3.1							
Hangesund							5.6	21.9	10.1						
Bergen	1,995	1,478	1,366	693	590	499	24.0	42.2	41.1	9.0	2.6	0.1	2.6	3.3	3.9
Aalesund				565	768	237	4.6	3.0	3.4	1.8			0.1	0.2	0.1
Molde							0.7	1.3	1.9						
Christiansund	55	10	6	2,335	1,714	2,131	16.7	20.7	16.2	0.1				0.4	0.2
Trondhjem	23	26	10				0.4	0.4	0.2				0.1	0.1	0.1
Bodo								2.2					0.1		0.6
Tromsø	398	390	153			3	1.0						0.2	0.6	0.5
Hammerfest	261	361	245				0.2	0.1					0.3	4.5	0.6
Vardø	38	195	106				0.6	0.6	0.1				3.1	13.4	17.5
Vadsø	94	178	631				0.2						1.0	3.0	0.5
Other places								0.2	1.0				0.1	0.2	
Total	2,865	2,659	2,699	3,599	3,074	2,873	64.1	128.5	99.7	10.9	2.6	0.1	13.0	32.2	24.5
Since January 1, 1883	†4.6	†7.3	†10.0	†20.5	†23.6	†26.5	278	406	506	34	36	37	42	74	98
1882	†6.7	†10.0	†13.3	†24.7	†27.7	†32.7	491	575	650	52	65	66	50	72	87
1881	†6.5	†11.0	†14.6	†27.7	†31.3	†34.3	591	735	884	44	49	52	62	81	104
1880	†8.3	†13.9	†16.7	†35.7	†40.0	†45.9	251	342	449	68	71	76	107	128	152
1879	†9.9	†14.9	†18.1	†28.4	†32.7	†37.3	382	504	636	51	53	56	94	111	127

* One hectoliter = about 22 gallons = about 2½ bushels.

† Millions of kilograms.



XII.—THE ICELAND COD FISHERIES IN 1883.*

BY C. TROLLE,

First Lieutenant in the Danish Navy.

The favorable reports which reached us from Faxa Bay, stating that very successful winter-fisheries had commenced near the southern part of Iceland (*Sonderlandet*) justified the hope that the fisheries on the west coast would also prove successful, and as the Loffoden fisheries had proved an entire failure, people began to look joyfully forward to high klip-fish prices, which would, to some extent, make up for the loss occasioned by the circumstance that the commercial treaty with Spain had not been concluded.

The fishermen therefore did not allow themselves to become discouraged by a rather unfavorable beginning, as there were frequent storms during May. Whenever there was good weather for fishing, it could readily be seen that there were plenty of fish, but, strange to say, as the season advanced, as June passed, and July began, the fish appeared less and less plenty at the regular fishing-places, and this in spite of the most favorable weather. The great expectations were gradually disappointed, and people began to sigh for a little of the wind which, in the beginning of the season, had interfered with the fisheries. Everybody seemed anxious to go to new fishing-places, for the fish surely must be somewhere or other, and all that had to be done was to search for them. As soon as a little breeze sprung up people became excited, and fishing vessels fully equipped for the fisheries could every now and then be seen at the fishing-places. It was of course to be expected that many, especially new beginners, under circumstances which demand a good deal of a genuine fisherman's patience, should lose much time in a fruitless chase after fish, but then no experience was ever gained without paying it.

The cod fisheries on the western banks in 1883 must, on the whole, be considered as poor and below those of an average year. The long-line fisheries in the eastern fiords did not fare much better. As regards numbers the results were satisfactory, but the fish were so exceedingly small that the total quantity was not large, and the prices, more-

* *Torske fiskeriet ved Island i 1883.* From the *Nationaltidende*, Copenhagen, February 9, 1884. Translated from the Danish by HERMAN JACOBSON.

over, were low, owing to the small size of the fish. Bait was unusually scarce. Without herring for bait the Faroe and Iceland fishermen seem to lose confidence, and all desire to row about and seek the most favorable fishing-places, but they will set their lines at random, which, of course is not generally productive of favorable results. The herring fisheries with nets were so poor during August and September, at any rate in the Reyder and Nord fiords, that people were actually surprised if twenty or thirty herring had, during the night, found their way into a net. In some cases the fishermen had to row several miles to neighboring fiords to buy fish from the Norwegians, who occasionally had caught some during the night, but it happened frequently that not a herring could be got, even for its weight in gold.

The general results were not very encouraging, and if some vessels succeeded in bringing home a considerable number of fish this only goes to prove that even in a poor fishing year the Iceland cod fisheries will repay the capital invested if they are managed systematically and economically, for it is a mistake to think that the fisheries consist in nothing but to draw the fish from the water, and expressions such as "the inexhaustible wealth of the sea" should never be understood literally.

As regards the results obtained by my vessel *Alma* in 1883, they cannot yet be stated accurately. The fish caught on the eastern coast are salted and laid to dry during the winter, and are not brought into the market till the following spring; but in reporting the course of our fisheries I intend to give all the data which can possibly be of interest, viz., the number and weight of the fish caught, the shrinking of the fish in salt and during the drying process, &c., from my own personal observations.

The *Alma* left Stavanger, Norway, on March 21, 1883, with a crew of 6 men, a supply of food sufficient for 18 men for about seven months, 250 tons of salt, a number of herring-kegs, &c., and fully equipped in every respect to take part in the Iceland fisheries. After having weathered a few severe storms from the north, the *Alma* reached the Faroe Islands on March 29, where we remained till April 12, in order to engage some more fishermen. I will not dwell on the difficulties connected with obtaining the necessary number of men for the *Alma* and the three fishing-smacks which were to accompany her, as I have described all this at full length in a former report; and I will confine myself merely to mentioning the fact that it was exceedingly difficult to induce the Faroe men to go to Iceland. These difficulties will probably increase from year to year as the Faroe people get more vessels of their own and engage more than formerly in deep-sea fisheries. With a total crew of 16, which in May was increased to 17, we left the Faroe Islands on April 12, and reached Cape Reikianæs on April 17. In Orebacks Bay we noticed some French schooners. These French vessels leave France as early as February, and in the beginning fish along the south of Iceland,

where they leave their traces in the shape of broken barrels, boards, &c., scattered along the coast. The results do not, as a general rule, bear any due proportion to the risk in fishing at this season of the year close to a coast like that of Southern Iceland, without a single place of refuge during a storm. The fishing expeditions from Denmark and the Faroe Islands generally do not reach Iceland till some time during the second half of March.

It had been my intention to begin the fisheries in Faxa Bay, from which place favorable reports had been received; but a severe storm from the northeast drove us out to sea and around the Blind Bird Rocks, and when the storm had abated it took us some time to reach land again, which was not till the 21st, when in the morning we had Kopparnæs to the southwest and Koger in the southeast. Here we reefed the sails with the exception of the mizzen, which is always set during the fisheries as if for sailing before the wind. While the vessel glides over the fishing-place it is necessary that some of the jibs should also be set, so that the lines which run out to leeward may trail out behind the vessel in an oblique direction. It should also be remarked that care must be taken that the vessel does not lie to leeward, whereby the lines, of which half a score hang out along the side of the gangway, easily become entangled.

The sounding-line showed a depth of 70 fathoms. Although it could hardly be expected to find fish at this time and at such a depth, we nevertheless made an attempt to fish, but without success, although in every other respect the conditions of time were as favorable as possible, viz., shortly before sunrise and near the change of the tide. Sailing towards the shore we tried different depths, as it was important for us to know in what direction fish might be looked for, but only at a depth of 40 fathoms did we find any codfish, principally large fish belonging to schools, with a shining white belly, and many of them having fully developed roe. As soon as a wind from the shore drove us to places where the water was 50 to 60 fathoms deep, we only met with halibut, wolf-fish, and occasionally some sharks. The first-mentioned kinds were so plentiful that in the course of a few hours we had from 20 to 30 on the deck of our vessel; of codfish we only caught from 100 to 150 during the first days, which, according to Iceland ideas, is considered a very poor result. Toward the end of the month we had a storm from the north with the temperature a little below freezing, and such a snow-storm that we were compelled to seek shelter in the Talkna fiord, which fortunately was not far off and which was all the more welcome as we remembered that the Bella and the Lovenorn had been lost in 1882 in this very neighborhood, probably because owing to the density of the snow-storm they could not find the proper place for approaching the shore.

The habit, which is unfortunately but too common among the fishermen, of seeking a port during a storm, should as a rule be discouraged as regards fishing-vessels. With the winds which generally prevail on the west coast of Iceland, viz., northeast and southwest, it will be possible

to fish in the shelter of the Fugle bjergene [Bird Mountains] in Brede Bay, or of the Riturhuk and Stigalid (along the deep portions of the Isa fiord), or the North Cape (Shagestrands Bay); especially as, during northeast winds, which generally bring storms in these latitudes, Brede Bay affords excellent shelter; and in this bay the Alma in 1883 twice found a place where she could safely ride at anchor during a storm.

As soon as the storm was over we rounded the Staalbjergbuk and anchored below the Fugle bjergene. In going round the Staalbjergbuk during a strong northeast wind care should be taken to avoid the breakers on the Rosten, a reef running out in the same direction as the Cape Staalbjergbuk, on which many vessels have been wrecked. The best way is either to pass close to the point of the Staalbjergbuk or to go out to sea a few miles before turning. The fishermen generally prefer to do the former. It is best to pass the cape when the storm begins to lull; but I would not advise any one to pass the cape after the storm from the northeast has raged violently for several hours.

There are a good many fish near the reef referred to, but in order to keep near the lines in the wild waves, which sometimes continue for several days after the storm has abated, it often becomes necessary to haul in the mizzen sail, and allow the vessel to be driven out to sea by the current, and even then the lines often become so badly entangled as to exhaust even the patience of a saint.

Until May 5th we had fair weather, and the Alma continued to fish from the Rosten up towards Straumnæs, where we made several good catches of from 300 to 400 large codfish. At the same time the Dyrafiord (one of our fishing-smacks) tried her luck near the North Cape, where fishing was fairly successful in the beginning of May. A few miles to the west of the North Cape the Dyrafiord succeeded in making four or five catches, realizing in all upwards of 3,000 codfish. An Iceland codfish vessel of 38 tons, the Havfruen (built in Kjørteminde, Denmark, in 1879), caught in the same region, on the 3d of May, 950; on the 4th, 954; and on the 5th, 1,208 codfish. It is true that the fish caught on these banks do not weigh as much as those caught on the west coast; while 1,000 west-coast fish will make 7 to 8 skippund [2,240 to 2,560 pounds] klip-fish, the same number of Northland fish will only make 6 skippund [1,920 pounds], but this is amply compensated for by the large number of fish. It was, therefore, a great disappointment when the ice began to interfere with fishing in this locality.

On the 7th of May the Alma unloaded her first cargo of fish at Thingyre. This cargo consisted of about 2,800 codfish, which, when salted, weighed about 30 skippund, [9,600 pounds], besides about 5 skippund [1,600 pounds] halibut and 2 skippund [640 pounds] wolf-fish. The weight therefore could not be complained of, which made amends for the comparatively small number, and all the more as nearly all the fish were of good size.

After the vessel had been cleaned and thoroughly overhauled, which should never be neglected with vessels which do not have a copper bottom, the Alma left Thingeyre on May 9, after a stay of two days, and sailed for Brede Bay, where, during the remaining part of May, the fisheries were continued, but not with any great success, as severe north-east storms raged nearly all the time. The anxiously expected south-west wind, which is said to be favorable for the fisheries, did not blow often, and only towards the end of July it blew a gale from that direction. It was probably the ice, which with small intervals lies in dense masses along the Northland coast until August, that kept the southwest wind in check. Many circumstances favor the opinion that the fish remain under the ice as long as it lies on the banks, for the ice affords them not only shelter but also light, and finally food, which is carried with it from the polar regions. As soon as the ice left the shore several good catches were made on the North Cape Banks. Thus the H. J. Baago from Svendborg, Denmark, secured 1,400 codfish in a single haul.

In June we had calm weather nearly all the time, and southerly winds prevailed. As the fisheries along the west coast down to Brede Bay had so far been very productive we tried our luck north of the Isafjord, and gradually approached the North Cape, where, on June 10, we came near the ice, which, at a distance of $1\frac{1}{2}$ Danish miles, about 7 English miles, surrounded the North Cape in an immense semicircle from Hælurvighjerget as far as the Skagestrands Bay, only separated in the middle by a narrow channel. As it was, therefore, impossible to get out to the fishing-grounds, and as the ice was constantly approaching the land, we took a westerly course and stopped at the Koger Bank, where some days previous we had made some good catches. A good fishing-place here is between the Riturhuk and Straumnæs, and between Koger and Husgavlen, where we caught 100 codfish, most of them weighing 50 pounds each and measuring between 4 and 5 feet in length.

On June 12 in the afternoon we noticed several large masses of ice which were drifting towards the shore about half a mile to the leeward. The wind was east. As it had been calm during the preceding days, I thought that they were merely isolated masses of ice which had accidentally drifted in this direction, but when I went up to the foretop I saw, to my astonishment, that the ice had surrounded us and lay in a vast semicircle towards the west, touching the shore at one point and stretching out to sea as far as the eye could reach. We saw several fishing-vessels manage to get through, and as fortunately a fresh breeze sprang up from the east, we embraced the favorable opportunity and slipped out in time. We first sailed in the direction of Straumnæs, and after having reached the edge of the ice we succeeded, after about an hour's sailing, in passing between some enormous masses of ice which presented a strange appearance, having all sorts of fantastic shapes, some resembling porticoes resting on long rows of pillars,

others having caverns whose depths shone in the most beautiful blue and green colors. On the following day the Isafiord, one of our fishing-smacks, slipped through, while the Dyrafiord was kept shut up in Hofn Bay for several days. The remaining part of June we fished along the west land, near Stigahlid, where on the 15th and 16th we sought shelter from a violent southwest wind. We caught a number of fish which were swimming in shoals—so-called herring codfish—most of them containing mature milt. This late spawning probably has some influence on the fisheries, as the fish are not so voracious during the spawning season. The low temperature of the air and water (the latter on an average $+ 4^{\circ}$ R. [41° F.] during June) and the strong current from the land, which is supposed to have had some connection with the unusual quantity of snow in 1883, great masses of water having rushed into the sea when the snow melted, may have been among the causes why there were so few fish on the banks. On June 23 there was a storm from the northeast (temperature of the air, $+ 2^{\circ}$ R. [$36\frac{1}{2}^{\circ}$ F.]) near the Fugle bjerge, but this storm lasted only till about noon of June 24, after which day we had fine summer weather (if such an expression can be applied to Iceland weather) all through June and far into July.

A gentle wind and a cloudy sky are the most favorable conditions for good line-fishing, while bright sunshine is unfavorable, as it seems to make the fish lazy. It seems very probable, at any rate, that they would rather snap after something that is alive than after a dead bait—just as other mortals. As soon as the wind had gone down, we chose a position near the Rosten as a starting-point, with an average depth of 45 fathoms. Hence we drifted with the current from Brede Bay in a westerly direction, where we reached a depth of from 60 to 70 fathoms. Here we found mostly torsk and sea-perch, and only a few codfish, most of them small. Owing to a continued calm, we were kept away from the land till the 30th of June, when a wind sprang up from the ENE. which allowed us to reach the coast near the Staalbjerghuk after a sail of about twelve hours. We had been driven out to sea from 8 to 10 Danish miles [about 42 English miles].

During the following days there was scarcely any wind, but, as the fish which had been caught during June must be landed, and as we intended to send letters home by the mail-steamer Laura, it was necessary that we should reach the Dyra fiord (Thingeyre) in a few days. If no wind sprung up, all we could do was to use the current running in a westerly direction; and in this way we managed to reach Sletnæs on July 3, and enter the Dyra fiord the same day. I mention this in order to show the advantages which fishing affords under such circumstances. While drifting along we fished, and near Straumnæs caught about 100 large and fat codfish at a depth of 15 fathoms, within a short time. When the current was very strong, we could not keep a sinker weighing 7 pounds on the bottom.

During the 4th and 5th of July we landed our fish at Thingeyre;

7,312 "torsk-kuller" [haddock, *Gadus aeglefinus*] weighed, when salted, 61 skippond, 228 pounds [19,748 lbs.]. On July 6 we left Dyra fiord (Thingeyre) on our last trip for this season, and continued our fisheries the same evening near Kopparnæs.

From this point down to the Fugle bjerge we found principally bottom cod, or "standing cod," as they are also called, with a dirty, gray belly. As a general rule there is more even fishing on banks where the fish make a steady sojourn than in places where one can only count on school-fish, as out near Varden. Of well-known wolf-fish grounds near the Westland, we would mention the region from the Suondar fiord as far as the Stigahlidsfjeld, the Arnar fiord, and the region between Bjarnanupr and Staalbjerghuk. With a northeast wind we sailed during the following days past Straumnæs, and a strong current from the north drifted us into Brede Bay, which has the reputation of being full of fish. During the forenoon we caught about 200 large, fat codfish, but unfortunately we were becalmed in the bay and could not get out till the evening of the following day. As soon after, when we had proceeded as far as Bjarnanupr, a strong wind sprang up from the northeast, and we had again to seek the shelter of Brede Bay, where we had successful fishing till July 21, when a southwest wind compelled us to leave.

Schools of codfish seemed now to have come to these regions in good earnest, and we made many catches, averaging 500 to 700 fish. Experience has taught me that the whole northern portion of the Brede Bay may be recommended as an excellent fishing-place, especially owing to the fact that the northeast wind is the prevailing wind along the Westland, for during this wind the bay affords good shelter. The bottom of the bay is very uneven and crossed in all directions by numerous furrows, which are the favorite resorts of the codfish. It should also be observed that wherever deep bays interrupt the coast-line, and where several currents meet, the fish will, as a general rule, find good feeding places, and consequently a great number of fish will be found in such places. This applies to the Rosten, the Ísa fiord, the bank near the North Cape, near Skagestrand, Grimsey, Langanæs, &c.

The remaining portion of July we drifted with a southwest wind along the shore of the Westland. From Myrakottr, in the middle of the Dyra fiord, and farther east we had good fishing on July 22 at a depth of 50 fathoms—large, fat codfish in schools, and among them a large number of small flounders, which make excellent bait. On the whole, however, the result was not above the average. The July fisheries, which are generally considered the best summer fisheries in these regions, yielded us only about 7,000 fish—about the same number as we caught in May, 1881. On July 29 our little fleet, composed of the Alma and the three fishing-smacks, Dyrafiord, Isafiord, and Patriksfiord, was united at the port of Thingeyre, and the following days we were busy in landing the fish we had caught, taking in salt, &c.

The yield of the Westland fisheries for the four vessels mentioned was as follows :

Vessels.	Salted codfish, ling, torsk, haddock, and sharks.		Salt halibut.	Salt wolf-fish.	Salt ray.	Sounds.		Liver.	Brine-salted keg-fish.
	No.	Weight.	Weight.	Weight.	No.	Dried.	Salted.		Fins, gills, &c.
		<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>		<i>Tons. Lbs.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons</i>
Alma	19, 516	53, 656	3, 372	5, 237	77	4 320		9	36
Dyråfjord	16, 087	46, 235	3, 753	5, 161			1	7	32
Isafjord	17, 921	49, 311	1, 677	4, 160				6½	23
Patriksfjord	18, 689	50, 430	2, 795	6, 883	12	½	3½	7	35
	72, 213	199, 082	11, 597	21, 441					

Of the total quantity of liver at least 4 tons were shark and ray liver; the cod therefore did not yield much liver, one ton of liver being counted to 2,888 codfish = 8,000 pounds salt fish. The livers this year were, moreover, very lean, as we obtained only 1,702 pounds oil from 29¼ tons liver, therefore not quite one-fourth. I am inclined, however, to ascribe some of this to the refining process, for as a general rule 3 tons of shark liver are expected to yield 2 tons of oil, and 2 tons of cod liver 1 ton of oil.

As regards the shrinking of the fish during the curing my own observations have led me to the following result :

Thirty-two thousand pounds of salt fish* yield about 22,720 pounds so-called "yacht-fish" (fish caught from the vessel), with the neck cut; or about 23,520 pounds so-called "yacht-fish," with the neck not cut; or about 22,688 pounds Spanish fish.

Thirty-two thousand pounds of salt halibut yield about 23,040 pounds dried halibut.

Thirty-two thousand pounds of wolf-fish yield about 21,440 pounds dried wolf-fish.

The cutting of the necks yields about 12 pounds of necks per 320 pounds of fish.

During the first days of August we left for the Eastland, there to engage in long-line fisheries from boats. Such has been the custom from time immemorial, and people do not seem inclined to give it up, although it would have been more advantageous if we had limited ourselves to short-line fisheries near the Westland and Northland, and continued these fisheries during September. That the Faroe fishermen, after having in July taken the fish caught at the Westland home to the Faroe Islands in order to have them dried the same year, would not find it advantageous to sail back again to the Westland, can easily be understood; but the Danish vessels, which deposit the fish caught by them on the Westland, should engage exclusively in short-line fisheries.

* By fish I understand codfish, ling, haddock, torsk, and coal-fish.

All the preparations for the long-line fisheries, as well as the trip to the Eastland, generally take up 14 days of the best fishing season, not taking into account that the long-line fisheries involve greater expenses.

On August 3 the *Alma* left Thingeyre, but did not get out to sea till the 5th, owing to calms and an easterly current. As it had been reported that the ice had gone away from the Northland, it was our intention to go round the Northland in a northerly direction; but when in the evening we reached the Isa fiord, a breeze sprang up from the ENE., and as at the same time the temperature fell to $+2^{\circ}$ R. [$36\frac{1}{2}^{\circ}$ F.], I thought that the ice was near again, and concluded to go round in a southerly direction, although this made the voyage longer by about 30 miles, and although the current was not favorable. We heard later that the Dyrafiord was forced to turn near the North Cape, and that the Patriksfiord escaped the ice only by sailing all the way down to Skagestrands Bay. Cape Reikianæs was passed on August 7th, Portland on the 10th, but after that we were becalmed and did not reach the Nord fiord till August 14. When we arrived we found 9 other codfish vessels. The first of these had come here in the beginning of the month, and had been successful, catching a good many large and heavy fish. There were here also some Norwegian vessels waiting for the herring, and Svend Foyn with his little steamer *Gratia*. He was superintending the erection of a large oil refinery. The long-line fisheries are carried on in the following manner: While the vessel lies at anchor in the fiord watching the herring nets, the crew are sent to sea in boats (20 to 24 feet long, built at the Faroe Islands), 3, 4, or 5 men being assigned to each boat, according to their size and the condition of the weather. On account of the currents the Faroe fishermen prefer a line which is not too long, having from 300 to 400 hooks, but which is drawn more frequently than longer lines. The fishermen of Denmark often use lines having 1,000 hooks. For bait are used fresh herring, halibut, wolf-fish, &c., and the baiting is done while the boat is being rowed out of the fiord. Our Danish fishermen would find it somewhat difficult to get accustomed to this mode of baiting, as in Denmark this is generally done by the "girls" before the boats leave the shore. Besides the Nord fiord the following fiords in this neighborhood are considered good codfish stations: Reyder, Faskrud, Bern, and Vapna fiords; and in the beginning of the season, Borgar and Bakka fiords.

The O fiord is doubtless a place which would make a good codfish station. It is one of the best herring inlets in Iceland, and it is well known that the codfish always follow the herring, which latter are also of importance as bait. The reason why no cod-fisheries have been attempted in the O fiord is probably this, that the Faroe fishermen, after having returned from their trip to the Faroe Islands, always choose the nearest fiords. For Danish vessels, however, it would be worth while to attempt cod-fisheries in the O fiord.

English fishing-smacks are in autumn generally engaged in fisheries

near Langanæs and Grimsey. The line-fisheries for school codfish, which go after the herring at a depth of 50 fathoms, are principally carried on near Langanæs. Some of these fishing-smacks towards the end of the season fill their tanks with live fish, which they sell in England, where fabulous sums are often paid for large live codfish and halibut.

The newly-built Norwegian fishing schooner Gunguer, from Tonsberg, built at Framnæs, near Sande Fiord, on the American plan, was last year engaged in the cod fisheries near Iceland. She was said to be owned by Svend Foyn, and as she came to the Nord fiord during our stay there, I had an opportunity of examining her. Her tonnage was 62; length, 80 feet; drew water $10\frac{1}{2}$ feet aft, and 8 feet forward. The rigging, fore and aft, was that of a schooner, with masts 70 feet long, and the hull was beech at the bottom, oak at the top, fastened with copper. Fully equipped, and with all the necessary fishing apparatus, she had cost 24,000 crowns [\$6,432]. She had 6 dories, 3 of which were fitted exactly within the other 3, so as to take up but little space. In the hold of the vessel there was a cabin, a forecastle for the sailors, a salt-room, and a bait-room, with an ice-room on each side, so that bait can be kept fresh for a long time. It had also been intended to place on board a steam oil-refining apparatus, so that medicinal oil could be prepared, as is done on most American vessels. The Gunguer had a crew of 14 Norwegians, who fished alternately with the hand line and with the long line, according to circumstances. When the long line is to be used, the vessel remains at anchor near the fishing station, and the dories go out, each with two men, but never very far from the vessel. Each boat has 1,000 hooks fixed on the American plan.

From the 14th to the 29th of August the Gunguer had caught about 8,000 codfish and about 5,000 pounds halibut. The latter (like the codfish) had been dry-salted, but it was the intention on returning to Norway to wash them and smoke them, making an article which is said to find a ready sale in America at 12 cents per pound. The Gunguer had fished all along the coast of the Northland, especially near Grimsey and Rodehuk (southwest from the Huk at a depth of 50 fathoms), and had come to the O fiord to secure a supply of fresh herring for bait. The above yield must be called very good, considering that the crew was small and inexperienced. It may be well to direct attention to the fact that these 14 men could fish with 5 or 6 boats, using 5,000 or 6,000 hooks, while our 18 men could only man 4 boats with about 1,500 hooks. Herein the Americans show their superiority, as they thoroughly understand how to use human strength in the most reasonable and economical manner.

Our fisheries came to a close on October 7, when the Alma left the Nordfiord. All in all, our fisheries had been interrupted for five days on account of stormy weather. The fish from all the 4 vessels were landed on the Faroe Islands to be dried there in the coming spring.

The result of the Eastland fisheries was as follows :

Vessels.	Salt cod, haddock, ling, torsk, and coal-fish.		Salt fins, gills, &c.	Liver.
	Number.	Weight.		
		<i>Pounds.</i>	<i>Ton.</i>	<i>Kegs.</i>
Alma	27,427	40,347	1	9½
Dýrafjörð	32,000	51,066		8
Ísafjörð	26,642	36,848		7
Patriksfjörð	26,172	42,200	1	9

Of the entire quantity (176,461 pounds salt fish) there were large fish, 50,880 pounds, or about 30 per cent; small fish, 79,360 pounds, or about 46.5 per cent; haddock, 36,480 pounds, or about 21.3 per cent; coal-fish, 3,840 pounds, or about 2.2 per cent.

The quantity of liver was, therefore, about 2.2 per cent of the weight of the fresh fish, one ton of liver being yielded by 2,400 codfish. Of the entire quantity of liver (33½ kegs) 27½ were landed on the Faroe Islands, and yielded 8 kegs of oil. The proportion was, therefore, two-sevenths, not much better than in the Westland fisheries, taking into consideration the greater fatness of the livers.

As regards the quantity of salt used, the result of my experience is as follows :

In 1881 I used for 83,840 pounds of cured fish 305 tons of salt, or 1½ tons per each 320 pounds.

In 1882 I used for 66,240 pounds of cured fish 264 tons of salt, or 1½ tons per each 320 pounds.

In 1883 for 291,200 pounds of cured fish 1,300 tons of salt, or 1½ tons per each 320 pounds.

The salt used during these three years was exclusively Liverpool salt, and I always counted 265 pounds of fish to a ton of salt. I should mention, however, that in 1883 the salt was too fine and therefore too weak, and turned to brine too rapidly. Some people prefer St. Ives salt, which is more expensive but coarser.

The total result of the Alma's Iceland fisheries in 1883, when salted, therefore represents a weight of about 106,350 pounds, which quantity of fish, when fresh (with the head and entrails), would be $2.7 \times 106,350$ pounds = 287,145 pounds, my observations having shown that the shrinking during the cleaning and while in the salt is $\frac{17}{27}$, leaving but $\frac{10}{27}$ of the original matter.

An average price of 7 ore per pound would therefore yield a gross income of 20,100 crowns [\$5,386.80], while the actual income will only be about 16,000 crowns [\$4,288]. Such a price for the fresh fish would correspond to 28 ore [between 6 and 7 cents] per pound of klip-fish, while 20 ore [about 5 cents] must be called a good average price for fish bought at first-hand.

One of the principal objects in developing our Iceland fisheries, therefore, should be to get the fish into the market in fresh condition; and all that is needed for this purpose are frequent and rapid means of communication.

For the sake of comparison between the quantity of fish in the North Sea and the Iceland waters, I will state that the average yield counted on by an English fishing-smack in the North Sea is 14,000 pounds per month, while the Alma in 1883, which was considered a poor fish year, caught about 48,000 pounds fresh fish per month near Iceland. That in trawl fisheries only 6 men are needed, while the Alma had 17, is of little importance; the principal point being that the capital invested should yield a reasonable interest.

But even apart from the question of fresh fish, I maintain that the cod-fisheries near Iceland can be very remunerative for our small sailing-vessels, and that, therefore, they should be of special interest for owners of such vessels. All that is needed is to get experienced men, especially captains, and to take account of all the products of the fisheries, not merely of the codfish alone, and put them to the best possible use. If once an interest is awakened in these fisheries, the Government will not be slow to extend its aid by publishing good maps, &c. The manufacture of medicinal oil on board the fishing-vessels, as well as the preparation of isinglass and other products from the fresh, undried sounds are probably among the subjects which should first of all be carefully studied by competent men.

There is hardly any doubt that the Association for the Promotion of the Fisheries in Denmark and its Colonies, which, it is hoped, will in the near future begin activity, can do a great deal towards the satisfactory solution of such problems; and it is therefore desirable that every one who takes a direct or indirect interest in the promotion of the sea-fisheries, will soon join this association, as its power for good will to a great extent depend on the number of its members.

XIII.—THE FISHERIES OF INDIA.*

By FRANCIS DAY, F. L. S., F. Z. S.,

Deputy surgeon-general (retired), formerly inspector-general of fisheries in India.

The subject which I shall have the honor to bring before you this evening is that of the fish and fisheries of India and its dependencies. Possibly there are other questions pertaining to the East which would prove more attractive and likely to engage attention than fish; but I think there is not one which could be selected more directly interesting to the teeming millions of our Indian Empire, and which requires so much investigation from our legislators, philanthropists, and scientific inquirers.

ORIGIN OF FISHERIES.—Doubtless one, perhaps the greatest, reason why many persons take an interest in this class of the vertebrate animals consists in the food they afford, and the occupation they give to man. But when we consider the subject more closely, we find that in our everyday life we are profiting extensively from the lessons which our ancestors received from the finny tribes. Man, in his savage condition, has the natural instinct of desiring food when hungry. Whether he can or cannot subsist solely upon vegetables is immaterial; his canine teeth demonstrate his carnivorous propensities, and, nauseated with a vegetarian diet, he would naturally seek change by the addition of animal substances. If living near water, more especially on the sea-coast, the hungry savage would first resort to such mollusks, crustaceans, and fish as he could capture in the shallows, or were left there by a receding tide; but as his wants increased, and the source of supply began to diminish, he would have to adopt other devices. He would wade after his prey, pursue them with spears, shoot them with bows and arrows, as the Andamanese do to this day, obtain them by setting up dams and weirs, or intoxicate them with poisons.

But, again (unless consequent upon some peculiar circumstances), the time would inevitably arrive when augmented captures would be desired; man would then have to venture further out, to dive after his prey, employ nets, to float upon a log, or fasten pieces of wood together as a raft, and in due succession would come the construction of a boat, and finally that of a ship—this last being necessary for the purpose of

* From Journal of the Society of Arts, pp. 609-628, London, May 4, 1883. A paper read in the Indian Section, Friday evening, April 20, 1883.

extending his range to better fishing-grounds, or exporting his spoils to distant markets. Consequently, the basis for navigation and commerce may reasonably be supposed to have been laid by man pursuing the finny tribes for the purpose of obtaining them for food, or conveying them dried or cured as an article of merchandise to transmarine countries. The very history of sea fisheries, which have been free to all, seems to point out that, as man increases in numbers, inshore captures of fish becomes insufficient for his requirements ; or else that continuous fishing may diminish the supply, rendering it equally necessary that the fisherman's occupation should be extended to more distant localities.

A.—FRESHWATER FISHERIES.

Freshwater fisheries differ in many respects from marine ones ; and we are all aware that, wherever any quantity of fresh water exists in the East, there we are almost certain to find fish ; and this from a sea level to nearly the summit of the highest mountains. As a natural result, fishing is had recourse to, in various ways, in rivers, irrigation canals, lakes, tanks, ditches, inundated fields, and swamps. The importance of such fisheries is not solely in a ratio as regards their productiveness, but also in accordance with the character of the adjacent people as to whether they are or not fish consumers ; while the sparseness or the density of the population has also to be taken into account.

Where no regulations are in force for the protection of inland fisheries, and should other circumstances be equal, that country or district which is most densely populated by man will be least so by fish. Individuals would rather live by fishing than by agriculture, because the trouble of capturing the finny tribes is less than that of tilling the soil. It becomes simply catching food, without a thought respecting future supply. Fish have been endowed with certain means of increase and protection ; the number of their eggs may be enormous, while some forms keep guard over their eggs and likewise over their fry, in order to afford them protection from their enemies.

As, however, man increases, watery wastes (wherein the fish had been protected by grass, reeds, bushes, and the roots of trees) become drained and cultivated ; predaceous man increases his means of destruction ; an augmented population, possibly assisted by the unscrupulous manufacturer or miner, pollute the previously wholesome water, and a diminution of the finny tribe becomes apparent to the investigator.

With an increasing fish-eating population an increased supply of fish thus becomes a self-evident necessity, and this must be provided for by augmented captures or higher prices ; the latter acting as a check on the poor, by more or less placing it out of their reach. This latter result may, consequently, eventuate in gradually diminishing the physical strength of the people. For a greater supply must be had from one of two sources, either from fisheries which previously have been insufficiently worked, or by overworking such as exist, by means of capturing

for present use those which ought to be left for a future season. Even if the extent of the water is so great, and the inhabitants so few, that this result need not be anticipated for several generations, still, populations under good systems of government have a natural tendency to increase. Means of carriage generally improve with time, and should neither regulation nor care of the fisheries be attempted, disastrous results must eventually be arrived at. Fish appear to have few friends and many enemies, and investigations as to their condition generally ends in giving increased license to their captors, for it is so easy to be liberal at other people's expense. We see interested parties and philanthropists (so-called) exclaiming against the hardship to the poor in not allowing every available fish to be secured. The majority of our law-makers are content to allow the fish to shift for themselves, and to leave the fishermen to be controlled simply by their own consciences. To-day's market, it is hoped, will be supplied; sufficient for this season, it is expected, may be obtained; so let to-morrow's wants be met as they can.

Classes of Indian fishermen.—The fishermen of the fresh water of India and Burma are divisible into two main classes: first, such as follow this calling as their sole means of livelihood; and, second, such as engage in it only occasionally, and as a subsidiary occupation. Who, then, are these Indian fishermen? Here, even within the limits of a single, or at least of a few generations, great innovations have crept in; for in the time of native rule, fishing was in the hands of distinct castes, but now it is only here and there that one comes across some remnants of these people, living in small communities, and frequently in the greatest poverty. At Combaconum, in Madras, there is a tradition that the fishing castes resident there were originally brought from Conjeveram as palanquin bearers, while at Broach, in Bombay, two subdivisions of these people are named in accordance with the villages from which they originally migrated.

Present decrease of fisheries.—In native states, fish have obtained great consideration. Thus in Mysore, in the time of Hyder Ali, very stringent fishery laws existed; whereas, at the present day, about two-thirds of the population of some divisions of the country occasionally add fishing to their other occupations, nearly every villager possessing a fish net or trap, to be employed as occasion or opportunity arises. Now fisheries are open to all; a fisherman's calling is no longer a profitable one, mainly due to the fisheries being depopulated. When whole districts were let to contractors, they were not so short-sighted as to permit an indiscriminate destruction; but now everybody does as he likes, when he likes, where he likes, and how he likes. Thus it has come to pass that among the animal productions of India, freshwater fish meet with the least sympathy and the greatest persecution; many forms having to struggle for bare existence in rivers which periodically diminish to small streams or even become a mere succession of pools,

or in tanks, from which the water totally disappears. They have their enemies in the egg stage, in their youth, and during their maturity; but among these man is their greatest foe, as any one who desires a fish diet captures these creatures whenever and wherever he gets the chance, irrespective of season, age, and size. In certain districts they simply appear to exist solely because man and vermin have been unable to destroy them.

Fisheries may be let to a contractor, and if their extent is large he takes partners or sublets portions; sometimes he employs servants, who are paid partly in money, or food, clothing, and lodging, and partly in a share of the captures. In some districts the fisheries, or a portion of them, are declared free, but a license fee is charged to the fishermen; or the general public is free to take fish for home consumption, but not for sale. Lastly, no regulations at all may exist, due to the general poverty of the fisheries, peculiar difficulties in their capture, or the general impecuniosity of the inhabitants.

When the public have more or less depleted fisheries, the fishermen become poorer and poorer, unless they turn to other sources of obtaining money; at first, no doubt pleased at the remission of rents, and the removal of all restrictions upon fishing, they employ redoubled energy, and thus augment their immediate profits. But soon the general public find that nothing precludes their fishing in any way they please; the markets become glutted, and the price may fall for the want of purchasers. But after two or three years fish become scarcer; fishing is no longer remunerative; removing the rents from fisheries and throwing them open to the public will not decrease the price of fish. The rates ruling in India are comparative to what obtains for meat and other articles of animal food. Fishermen, living on free fisheries, do not dispose of their capture below market rate, any more than farmers who possess rent-free farms sell the produce at less than their neighbors. If the fisherman benefits, the purchaser does not, and their misapplied energy eventuates in nothing but small fish remaining. The young have to be raised from ova of such as are merely one or two seasons old, while the younger the parent the smaller the eggs, and this, I believe, is one mode in which races of fish may deteriorate.

Natural and artificial causes affecting fisheries.—The rivers which have alpine sources, as such as descend from the Himalayas, have, exclusive of springs, two most abundant sources of replenishment. During the hot months this is derived from melted ice and snow, while during the monsoons the rains assist; we may then have the hill rivers forming torrents, rising rapidly, and as rapidly subsiding, and possessing no contiguous tanks into which the fish could retire. These animals are peculiar, or endowed with means of existence differing from such as live wholly or mostly in waters of the plains. Many of the fish are provided with adhesive suckers, situated behind the lower jaw or placed on the

chest, which enable them to fix themselves against rocks, and so prevent their being washed away by the stream.

Through the cold months, and generally until the setting in of the southwest monsoon in June, rivers are at their lowest, some at this period (especially in hilly regions) being merely a succession of pools, united by a more or less significant stream, in which limited localities the fish take refuge, and may be easily secured by fishermen.

Among the artificial causes affecting fisheries in many districts are the irrigation works, which are formed by throwing a weir or bund across a river, and diverting a large amount of its water down a main irrigation canal. These weirs are usually built as stone walls across the entire breadth of the rivers, and consequently impede both the upward and downward passage of fish that are endeavoring to migrate, while, should they be sufficiently high, they entirely stop them. Where large under-sluices are present, fish can pass up such when open; but up the long narrow ones, as constructed in Madras, the strength of the current renders this impossible. The under-sluices are here closed, except where there is an excess of water, as during the monsoon months; and as the weirs have no fish-ways, not only is ascent towards the breeding-grounds intercepted, but fisherman are permitted to capture the fish which are detained here. Standing on those weirs, one can see the fish jumping against the obstruction, which they vainly hope to surmount; some strike against the piers of the bridge, others fall into the cascades, descending over its summit; but to them the wall is an impassable obstacle.

The irrigation canals may be said to be streams obtained by diverting a large amount of water from a river into a new channel, and this, of course, would be taken from above the weir; consequently, all fish descending the river would be diverted into the irrigation canal. If these canals are constructed for navigation as well as for irrigation, the fish can pass along them; but if due to falls, they are unsuited to navigation, then the fish can descend them, but are unable to reascend. They then become vast fish-traps, wherein all the finny inhabitants are destroyed whenever the canals are run dry in order to examine their condition and see what annual repairs are necessary. Passing off on either side of these canals are lateral irrigation channels, which are employed to water the crops directly, and at each successive replenishment of these another shoal of fish passes to inevitable destruction. Unprovided with gratings at their entrance, and kept filled only on alternate weeks, all the fish which enter invariably perish. The same destructive process exists throughout India wherever irrigation is carried on.

As the yearly rains cause inundations of the country by the overflowing of the rivers and tanks, fish move about in order to find suitable localities for breeding in, and the small streams and their outlets resemble the net-work of irrigation channels. Many species ascend them to spawn, but find at every turn appliances invented by man ready for

their destruction. Persons may be watching to intercept them, engines or traps may be fixed in their course; or, should any breeding fish succeed in effecting their ascent, means are taken to insnare them on their return, while the fry are destroyed in enormous quantities—a proceeding which has been declared not to be waste because they are eaten.

Then there are tanks, some of which are, others are not, in connection with running water. Should they entirely dry up during the hot months, only such fish as bury themselves in the mud will survive to the next rainy season. As a rule, the owner of a tank, if it is employed also for fish-culture, leaves one portion (the deepest) in order to retain sufficient water to keep the finny residents alive, while, if very hot, boughs of trees or tatties are placed over this locality to mitigate the heat.

I shall now pass on to consider the fishes inhabiting the fresh water of India, Burma, and Ceylon. They may be divided into (1) those which enter from the sea for breeding or predaceous purposes, and (2) such as, more or less, pass their lives without descending to the salt water. The first class I do not propose giving any detailed description of, unless casually remarking upon such when the breeding of fish or the fisheries come under review.

Varieties of freshwater fish.—An exhaustive account of all the strictly freshwater forms would doubtless be interesting scientifically, but hardly so to the fisherman or general reader; consequently I shall restrict myself to observing that the fisheries alluded to contain about 369 species, appertaining to 87 genera. Of the spiny-rayed, or *Acanthopterygian* order, we have 19 genera, the members of which are most numerous in the maritime districts and deltas of large rivers, while their numbers decrease as we proceed further inland. Few are of much economic importance, if we except the common goby, spined-eels (*Mastacembelidæ*), the snake-headed walking-fishes (*Ophiocephalidæ*), and the labyrinthiform climbing-perch and its allies.*

Of the sheat-fish, or scaleless siluroids, we have 26 genera. The mouths of these forms are provided with sensitive feelers, which, serving as organs of touch, assist them while seeking their prey in turbid waters. All that are of sufficient size are esteemed as food, although, owing to their propensity for consuming unsavory substances, their wholesomeness appears, at times, to be questionable. The next 3 genera, gar-pike (*Belone*), Cyprinodon, and Haplochilus, are of but little value, but the 35 genera of carps and loaches are of the greatest possible consequence, affording a large amount of food to the population of the country. The remaining 4 genera, consisting of the curiously flattened *Notopterus* and 3 forms of eels, are of but little mercantile importance.

* These air-breathing fishes are of great economic importance; thus, when poisonous ingredients are washed into rivers, on the first burst of the monsoon, the fishes die, unless they are direct air-breathers, taking in atmospheric air direct, when they are often able to exist until the poison has passed down stream.

1.—REPRODUCTION OF FISH.

How the reproduction of these fishes is carried on becomes a most necessary investigation, and in briefly considering such we might inquire into what migrations they undertake for this purpose? Whether the parents are monogamous, polygamous, or are annuals, dying after the reproductive process has been accomplished? The time of year when spawning occurs? Whether such is or is not deleterious to the parent? The size of the eggs, their color, whether they float or sink, are deposited in running or stagnant waters? If they are covered or left uncovered in their nests? If the male carries them about or protects them? Can their germination be retarded by artificial means or natural causes, as by the action of cold or their immersion in mud?

Migration of spawning fish.—That anadromous forms, as the salmon or shad of Europe, or the shad (*Ulupea palasah*) of India, migrate from the sea to the fresh waters to deposit their eggs in localities most suitable for their reception is well known. If we examine into the migration of Indian fishes for breeding purposes in fresh waters, we find that such takes place under three conditions, viz.: (1) Anadromous forms from the sea to the fresh waters, as already adverted to; (2) Such species as may be considered pertaining to the mountains, or else deposit their ova in the rivers of the hills; (3) Such as are restricted to the plains, but which likewise undertake certain changes of locality at these periods. Of the migratory hill-fishes the various forms of large barbels (*Barbus*), termed *mahaseers*, furnish good examples. In the Himalayas they ascend the main rivers, but turn into the side streams to breed, while on the less elevated Neilgherry Mountains, in the Madras Presidency, the same phenomenon occurs, but with this difference, that they deposit their ova in the main streams because such are small, and perhaps due to their never being replenished with snow-water. Occasionally the fish are too large to ascend these mountain rivers, when they would appear to breed at the bases of the hills. Whether it is from the offspring of such that this genus has extended through the plains it is not my purpose to inquire in this place. When the rivers commence being in flood, adults are able to ascend to feeding-grounds which were previously inaccessible to them. Having spawned, they keep dropping gently down stream, during which time the amount of water is diminishing; thus the ova, when hatched, are completely cut off from the locality where their parents reside, precluding their making a meal of them. The fry, therefore, have the heads of the rivers to themselves in perfect security, and each torrent becomes transformed into a small stream intersected by pools, where they can remain until the next rain enables them to descend to the larger rivers. Of the migratory fishes of the plains we may observe many forms of carp, and this is more particularly observable where impassable weirs exist in Indian rivers; here they may be perceived in attempting to jump over the obstruction, and so common

is this phenomenon that the natives of India hang baskets, cloths, even native cots turned upside down, or anything equally suitable, over the sides of the piers, and into these the fish fall.

Monogamous and polygamous fish.—In Asiatic waters we have monogamous and polygamous forms and other phenomena as to breeding, which deserve attention. The walking, or snake-headed fishes (*Ophiocephalidæ*) of India, and other amphibious genera, are perhaps the best known of monogamous fishes; some of them reside in ponds, others prefer rivers, where they take up their residence in deserted holes which they find in the banks. The pond species delight in lying at the grassy margins, where the water is not deep enough to cover them, and here they are able to respire atmospheric air direct. The striped walking-fish constructs a nest with its tail among the vegetation, and bites off the ends of the waterweeds; here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. The hissar, *Callichthys*, of South America, is likewise monogamous, constructing nests, which it also defends. The majority of fishes unquestionably are polygamous, as has been repeatedly observed, and, perhaps, as distinctly among the salmon as any other form in a wild state, and likewise in sticklebacks resident in aquaria; while, doubtless, fishes which migrate in shoals for breeding purposes, as the mackerel, herring, or some forms of carp, are all polygamous.

Time of spawning.—The time of the year at which spawning is effected varies in accordance with the locality and the family of fish. This again appears to be further susceptible of modifications in accordance with the temperature of the water, and many other local causes, while there are some fishes which breed only once a year, others more frequently. I must here premise that some fishes do not appear to feed during the season of depositing their spawn, as the salmon, the shad, and the siluroid *Arinae*. In India an anadromous shad, termed "Pulla" in the Indus, "Ulum" by the Tamils, "Sable-fish" by the Madrasees, "Palasah" by the Telingis, "Hilsa" or "Ilisha" in Bengal, "Nga-thalouk" by the Burmese, breeds in rivers as already described. In Sind they ascend the Indus in February to spawn, descending in September. In the Cauvery, in Madras, they pass up when the first burst of the June monsoon fills the river, and they continue doing so for the succeeding four montas. In the Krishna, which has a far greater velocity, but, similarly to the Cauvery, is filled in June, they defer their ascent until September, but it is not until the end of the month or commencement of October, when the river is subsiding and its velocity decreasing, that the majority arrive; whereas in the neighboring river, the Godavari, in which the current is less rapid, these fish ascend earlier to spawn, being most numerous from July to September. In the Hooghly they continue ascending throughout the June monsoon, and many are found still in roe in September. The main bodies of these fish ascend the

large rivers of India and Burma generally when the June monsoon commences, but not always at the same period, such apparently at times being dependent upon the rapidity of the current and other causes. That it is not due solely to the presence of rain-water flooding the river is evident, because those of the Indus and Irawadi are mainly caused by melting snows at this period, and likewise in the latter river these fishes push on to Upper Burma, to which country the monsoon scarcely extends, but where the inundations are due to snow floods. Probably the cause of the majority of fishes at these various periods ascending the different rivers to spawn may be due to their having been bred there, while inherited instinct causes them to select the most suitable times, when the shallows are covered with water and ascent is rendered practicable. It is evident that members of the same family, genus, or even species, may spawn at very different periods, due to local or climatic causes. There are also fishes which deposit their ova twice yearly, if not more frequently; these are generally freshwater forms, and are not rare, especially in tropical countries; as an example we have the walking-fishes.

Effect of spawning on parent fish.—Has spawning any deleterious effect upon the parent fishes? To this, two replies may be given, as in some cases it renders their flesh unwholesome, while in others it does not cause their character as to food to be altered. The shad in the East are excellent eating up to the period when they have deposited their eggs, subsequent to which they become thin, flabby, and positively unwholesome; the salmon have similarly an unhealthy lean and lank condition, rendering them unsuitable for the table. Freshwater fishes that deposit a smaller number of eggs, or, perhaps, do so more gradually, or twice at least during the year, do not invariably appear to be so deleteriously affected by breeding, this condition being more restricted to the anadromous forms.

Size, color, and protection of eggs.—The size of the eggs, their color, and whether deposited in ponds or in the sea, are likewise questions affecting the breeding of fish. The forms which produce the greatest number of eggs are often those which live in large communities and spawn once a year. In an Indian shad I found 1,023,645 eggs. But other forms have likewise numerous eggs. I observed 410,500 in a barbel (*Barbus sarana*); on the other hand, some fishes have large eggs, as a few of the sheat-fishes, and a genus of carp (*Barilius*). In such as spawn at least twice a year, and likewise protect their young, the number of eggs is less than what generally obtains in other genera; thus in a walking-fish (*Ophiocephalus*) I found 4,700.

As to the color of fish eggs, they are very diversified; in some freshwater siluroids they are of a light pea-green, as I have observed in the scorpion fish (*Saccobranchus fossilis*). Respecting the localities where fish deposit their eggs, these are exceedingly various, as might be anticipated, owing to some sinking in the water while others float. The

gar-fish (*Belone*), and the flying fish (*Exocætus*), have filaments springing from their eggs for the purpose of attaching themselves to contiguous objects; others are covered with a glutinous secretion. In fresh waters eggs may remain at the bottom, either covered or uncovered.

Among the marine siluroids (*Ariinæ*), the male carries about the large eggs in his mouth until hatched; or it may be that he only removes them from one spot to another to avoid some impending danger. However this may be, I have netted many along the seacoast with from ten to twenty eggs in their mouths, and in one example was a young fry just hatched. In none of these large males was there the trace of any food in their stomachs.

Artificial hatching and transportation.—Bloch, at the end of the last century, made many experiments as to the feasibility of fish being artificially hatched, and also whether it was possible to convey the ova in safety for any considerable distance. He proposed placing the eggs of pond fish in mud, similar to that existing in the locality from which the eggs were procured, and he believed that when the mass had dried they could be thus removed without injury from one pond to another. His proposal was based upon the theory that frequently on dried-up ponds being refilled with water, young fish appear, which could only be due to the eggs having been present in the mud, but with their germination suspended. In India, as ponds dry up, some of the fish contained therein descend into the mud, where they estivate until the next year's rains set in. As these commence, and the mud liquefies, fish are perceived diverging in all directions, up every watercourse, no matter how small or how lately it may have been dry, while in a few days fry are distributed everywhere. Where the eggs come from which have produced these fry is a very interesting subject for investigation. Have they remained inside the mother fish, and did she deposit them as soon as the rains set her free? I cannot accept this theory, because I have witnessed fish removed alive from the mud, but they had no ova; and, secondly, because the fry are soon hatched after the setting in of the rains, while some of these fish are oviparous. It seems more reasonable to suppose that the fertilized eggs are imbedded in the mud, and, as soon as the rains occur, they become hatched out, and this would give us reason for attempting to ascertain whether ova of pond fishes imbedded in mud could be successfully transported long distances.

We know that germination of fish eggs can be retarded by cold. In fact, by the use of ice, those of trout and salmon have been safely conveyed to Tasmania and elsewhere.

2.—LEGISLATION ON FISHERIES.

Royalties and licenses in former times.—From the information collected between 1869 and 1873, it appeared that the fisheries in olden times were royalties, mostly let out to contractors, who alone in their respect-

ive districts possessed the right to sell fish, while they, as a rule, permitted the people, on payment, to capture sufficient for their own households. It was, in fact, a license on payment, resumable at will. Remains of this custom still exist in Lahore, while the leasing of fisheries is even now in force in many portions of the Indian Empire. Along the Himalayas, in the Kangra and other districts, the petty rajahs adopted a different method. To some persons they gave licenses to supply the fishmarkets, of which they virtually made them monopolists, while others obtained licenses for fishing with small nets for home consumption, but not for sale. In Burma, under native rule, a similar plan was carried out. There were no free fisheries, but inhabitants had the privilege, or perhaps right, to fish for home consumption on the payment of a fixed annual sum to the contractor for the district in which they reside. It is believed that under native rule the erection of fishing weirs was permitted in several of the streams in the Himalayas, but not to the extent that it is at the present day. In some districts landowners even now raise an income from the fisheries, claiming a third of the captures or a certain amount of money. Some of our officials consider that as the Government has permitted indiscriminate fishing, the exercise of long practice has converted such into a communal right.

Fishing under British rule.—As British rule has gradually superseded that of the native princes, so the modes in which fisheries were leased have become widely different, and in permanently settled estates, unless a stipulation to the contrary exists, they go with the land. In some localities it has been decided that the adjacent villagers or people possess certain communal rights with respect to them, due, it seems most likely, to a misapprehension. Although it has been proved that the landowner never received more than one-third of the produce, this does not demonstrate that the other two-thirds were public property, but that such expressed the share accruing to the fisherman in return for his labor in capturing the fish. It is the rule in India and Burma to remunerate by the proceeds. Sometimes the working fisherman has to dispose of his share to the contractor or lessee at a given rate; more rarely the fish are sold, and he receives a proportion of the returns, or he may be paid in kind. In some localities the British Government has leased fisheries, or imposed a tax on the implements of fishing, or a capitation tax upon the fishermen, but without interfering with the manner in which the fisheries were conducted. By degrees the tax on fishing implements was taken off, but the fishermen still became poorer, and in 1849, at least in Madras, many leased fisheries were thrown open to the public, resulting, as they were not regulated, in unlimited license, and thus an intended boon resulted in their depopulation. In Burma, the practice of employing fixed engines in irrigated fields and water-courses very largely increased when the native regime became abolished, as did also the custom of throwing weirs across creeks and minor streams.

Injury caused by free fishing.—Free fisheries have been permitted, due to several causes, such as the difficulty in making such sufficiently remunerative to bear taxation or the incidence of rent. This may be owing to the rapidity of the current, the paucity of fish, as in some hill streams and depopulated rivers, the depths of tanks, the presence of foreign substances in them, or the poverty of the general population. How general and indiscriminate fishing ruins fisheries, without any commensurate benefit accruing to the public, I have already stated. In these deteriorated but public fisheries, as soon as the monsoon has set in and the fry are commencing to move about, women and children are daily engaged in searching for them in every sheltered spot where they have retired for security, as, not being able to face strong currents or live in deep waters, they naturally resort to the grassy but inundated borders of rivers and tanks. Every device that can be thought of is now called into use; nets which will not let a mosquito pass are employed; even the use of cloths may be frequently observed. Neither are the agricultural population idle. They construct traps of wicker-work, baskets, and nets; these traps permit nothing but water to pass, and a fish once inside is unable to return, as they resemble some of our commoner kinds of rat-traps. So soon as fish for the purpose of breeding commence passing up the small watercourses at the sides of rivers and streams, these implements of capture come into use; breeding fish are taken, and the few which surmount the obstructions find the traps reversed, so that, although they have ascended in safety, it is by no means improbable that their return to the river will yet be cut off. In Burma a large triangular-shaped basket is employed in places where trapping is difficult, and a pair of buffaloes having been harnessed to it, it is dragged through the localities inhabited by the fry. Even when there are no restrictions, fishermen often find it advantageous to ply their occupation in concert. Sometimes large bodies of villagers proceed at certain seasons of the year to rivers which can be easily bunded, having done which, they kill every fish they are able.

Size of the meshes of nets.—In investigating what is the minimum size of the meshes of the nets in general use in India and Burma (excluding Sind), where no regulations exist declaring what such should be, I received the following replies from ninety-one native officials:

Five native officials report 1 inch as the size between knot and knot of meshes; five report below 1 inch; eighteen report one-half inch; five report one-third inch; twenty-four report one-fourth inch; one reports one-fifth inch; five report one-sixth inch; eighteen report one-eighth inch; four report one-tenth inch; two report one-twelfth inch; three reports one-sixteenth inch; one reports one thirty-second inch. And out of seventy more returns, fifty-three officials compared the size of the mesh to a grain of wheat, mothi, mucca, gram, dholl, lamp-oil seed, barley, tamarind seed, a small pea, a peppercorn, a large needle, a bodkin, quill, coarse muslin, will ensnare a gnat, or hardly anything passes. The

remaining seventeen described the smallest size as follows: Size of finger or thumb, five; of half ring-finger, two; as big as a broomstick, one; size of half rupee, one; of a four-anna bit, one; of a quarter of an anna, one; of a two-anna bit, five; of a pie, one.

Fixed fishing apparatus.—The fixed engines employed in India and Burma are mainly divisible into two forms: (1) Those manufactured of cotton, hemp, aloe fiber, coir, or some such material; and (2) others constructed of split bamboo, rattan, reed, grass, or some more or less inelastic substance. Those which are manufactured of elastic substances include all stake-nets, but when the meshes are of a fair size they are a legitimate means, when properly employed, for the capture of fish, but are occasionally to be deprecated, especially when used solely to take such as are breeding. But in some of these implements the size of the mesh is so minute that no fish are able to pass. There it stands, immovably fixed across an entire waterway, capturing everything, the water being literally strained through it. In one instance, in the Panjab, a whole shoal of mahaseer was observed to be captured by natives fixing a net across a river, and then dragging another down to it, thus occasioning wholesale destruction, and ruining the rod-fishing for the succeeding season. This plan is a very common procedure throughout India, as is also constructing earthen dams across streams, leaving a channel or opening through their center, where a purse-net is fixed, and arrests every descending fish. The largest numbers are taken towards the end of the rainy season, for as the waters fall countless lakes and pools of all sizes are formed on the lowlands in the vicinity of rivers. These, which during the floods were lateral extensions of the stream, now become lakes, having one or more narrow outlets into the river; across each opening nets are stretched, or a weir of grass constructed, and every fish which has wandered up becomes a certain prey to the fishermen.

Fixed engines constructed of non-elastic substances are still more destructive to fish than are such as are made of net, and which are more liable to be rent. Their forms are exceedingly numerous, their sizes infinite, while the interstices, between the substances of which the weirs or traps are composed, appear everywhere much the same, whether examined in the ghats of Canara, the yomas of Pegu, the Himalayas, or on the plains of India or Burma. Still, local influences must occasion some modifications. In hilly districts, as the monsoon floods subside and the impetuosity of the mountain torrents has decreased, they can be erected without being liable to be washed away. Up the hill streams (as I have already observed) some of the most valuable of the carp ascend to breed, and there are now but few which are not weired, and the parent fishes have the greatest difficulty in reaching their spawning grounds. Some, however, surmount the difficulties opposing their ascent; a few deposit their spawn; this completed, the rains are now passing off, the force of the current lessening; but what now occurs to those

fishes which commence descending, trying to regain their low country rivers? I omit in this place how spearing, snatching, or snagging, netting, and angling are carried on, only referring to how fixed engines are employed. Weirs are now erected every few miles, through which the waters of the hill streams are literally strained, while each is fitted with a cruive or fishing trap. The probabilities are that the great majority of the mahaseer which reach the rivers of the plains are the last year's fry that have fortunately escaped destruction during the dry months, and with the first floods have obtained a free highway by the standing weirs being swept away. Wicker traps are likewise constructed across convenient rapids; here few fish can pass without entering, while these are examined twice daily. Or should there be no rapids, such are artificially formed by laying large stones in a V-shape across a stream, while at the apex of this is a trap. Or a mountain stream is conducted down a slope over a large concave basket, so that all descending fish are pitched into it, and speedily suffocated by the rushing water or other falling fish, which act like a succession of blows, preventing their ever rising again.

In addition to the larger weirs and traps, there are minor sorts most extensively employed, especially in the plains; some to capture breeding fish ascending up the smaller watercourse during the rain to deposit their spawn, others to arrest them and their fry attempting to descend the stream as the flood waters recede; and there is not a district, except perhaps in Sind, in which this mode of capture is not carried on. And some officials now speak of the use of these contrivances as communal and prescriptive rights, and their prohibition as an interference with private property.

Movable fishing apparatus.—Movable fishing implements are of two varieties: (1) Those manufactured of cotton, hemp, aloe-fiber, coir, or of some such material; and (2) others made of split bamboo, rattan, reed, grass, or other more or less elastic substances. Large drag-nets, having fair-sized meshes, are used mostly during the dry months, and employed for the purpose of obtaining fish from pools in rivers into which they have retired awaiting the next year's floods. But the movable nets which occasion the most damage are those with small meshes, and principally employed for taking the fry of the fish as they are first moving about; they may be cast-nets with fine meshes, wall-nets dragging up some small watercourses, purse-nets similarly used, and even sheets may be thus employed. In some places several cast-nets are joined together, to stop up all passage of fish along a stream, while others are employed above this obstacle; or several fishermen surround a pool, each armed with a cast-net, and these they throw altogether, giving the fish but little chance of escaping. In Sind the fishermen float down the Indus, in certain suitable localities, upon a gourd or hollow earthen pot, while the net is let down below them; as a hilsa fish, *Clupea ilisha*, ascends up the muddy and rapid stream, it strikes against the dependent net, which is

made to contract like a purse by means of a string that the fisherman holds in his hand.

Irrespective of the modes already detailed as in common use for capturing freshwater fish in India and Burma, there are a number of what may be termed minor plans likewise in force. Sheets have already been remarked upon as employed for taking the fry which have ascended small watercourses, or are found in shallow water, while they may also be used as dip-nets, being sunk in an appropriate place, and raised by strings attached to the four corners, as soon as the fish have been enticed above. Or on the bushes sheets may be placed; here the fry seek shelter from the rays of the sun, and the whole concern is lifted bodily up. A little grain or bread is likewise found useful as a bait. Two pieces of rattan may be employed, crossing one another in the middle, where they are tied together; the ends are then bent downwards in the form of two arches. Here a net is attached, and this the fisherman presses down upon the fish, which are then removed by the hand. In some places they may be so frightened as to permit themselves to be readily taken; thus ropes to which at intervals are attached bones, leaves, stalks of kurbi or jowaree, or pieces of solar (pith), or small bundles of grass, are stretched across a stream; two persons, one at each end, constantly jerk this rope, causing the fish to dart away towards nets that are fixed to entrap them. Snares of the most varied descriptions are almost universally employed; but in some localities angling may be said to be almost unknown, especially in Orissa, or districts where wholesale poaching is preferred as easier and more successful. One method of using hooks is perhaps as cruel as could well be devised. A number are securely fixed, at regular intervals of about 3 inches, to a line for employment in a narrow pass in a hill stream. When used, the rope is sunk from 18 inches to 2 feet below the surface, and held by a man on either bank; others drive the fish towards this armed cord, and as they pass over it the line is jerked for the purpose of hooking the game. In some places dexterity has been arrived at by constant practice, and many fish are thus captured. The desire is to hook the game by its under surface, but, as might be supposed, although in some cases the hooks penetrate sufficiently deep to obtain a secure hold, such is by no means invariably the case. The struggles of the wounded creature frequently are sufficient to allow it to break away, often with a portion of its intestines trailing behind it. If its gill-covers have been injured, respiration may be wholly or partially impeded; crippled, it wanders away to sicken and die in an emaciated state, while, should it be captured before death has stopped its sufferings, it is useless as food, unless to the lower animals. Baited hooks are in some places fastened to lines which are tied to bamboos fixed in the beds of rivers, or to bushes or posts at their edges, and so managed that when a fish is hooked the line runs out. Or a somewhat similar plan is to have a cord stretched across a river, floated by gourds; to

this the short lines which have the baited hooks are attached, but so that they are not long enough to reach the bottom; these are visited every few hours. In some districts night-lines are baited with frogs. Spearing fish by torch-light is extensively practiced in the Punjab and in the Presidency of Bombay, or they may be speared during the day-time in the cold months of the year, when they are not very active. Two persons usually engage in this occupation; the one punts the boat along as noiselessly as possible, while the fisherman stands at the prow silently pointing to the direction to be adopted, and uses his spear when he gets a chance. Shooting fish with guns is carried on in Oudh, and occasionally elsewhere. This is more especially employed for the snake-headed walking-fishes (*Ophiocephalidae*), which are frequently seen floating on the surface of the water as if asleep. They may be approached very closely, but the game usually sinks when killed, and has to be dived for or otherwise obtained. Cross-bows are also employed for a similar purpose in Malabar. In Mysore—observed the native officials of the Nagar division—fish are taken by nets, traps, hooks, cloths, by the hand, by baskets of different shapes, by damming and draining off the water, by shooting, by striking them with clubs, swords, or choppers, by weirs, and by various descriptions of fixed engines; in short, by poaching practices of every kind, as well as by fishing with rods and lines, and poisoning pools of water. Even fishes' eggs do not escape the general hunt to which the persecuted finny tribes are subjected in these days, the ova being collected and made into cakes, which are considered a delicacy.

Animals destructive to fish.—There are certain vermin in the East which are destructive to fish, some when in the immature, others when in their matured state. Commencing with the crocodiles, two distinct genera have representatives in the waters of India. The true fish-eating crocodile, *Gavialis gangeticus*, with its long and slender snout, attains upwards of 20 feet in length, and is a resident throughout the main courses and affluents of the Indus, Ganges, Brahmapootra, and Mahanadi Rivers, but absent from Burma, and most of those in Bombay and Madras. This species is usually afraid of man, except when he invades the locality where it has deposited its eggs. Their diet appears to consist mainly of fish, turtles, and tortoises. In 1868, I found it was one of the sights of Cuttack to watch these enormous reptiles feeding in the river below the irrigation weir which impedes the upward ascent of breeding fish. The long brown snout of the crocodile would be seen rising to the surface of the water holding a fish cross-wise between its jaws; next, the finny prey was flung upwards, when, descending head foremost, it fell conveniently into the captor's comparatively small mouth.

Crocodiles, like predaceous fishes, swallow the finny tribes head first, because, if they are of the spiny-rayed forms, their spines are thus pushed backwards, lie flat, and do not injure the creature which is

swallowing them. Were they taken in tail first, this would erect the spines, and wound every animal which should endeavor to swallow them. Doubtless some forms, while in transit, wriggle themselves round, and get fixed in the gullet of their captors, as the fatherlasher of our coasts.

To show their prolific powers, I may observe that the overseer in charge of the Narrage weir in Orissa came across a brood, and within three hours shot sixty-nine. When at this place I obtained a young one that had become entangled by its teeth in a fishing-net, and asked the fishermen if they ever destroyed them. Astonishment was depicted on their faces, and they protested against the supposition that they had ever been guilty of such a mean action. Their argument was that both classes belonged to the fish-destroying races, therefore, on the principle that hawks do not pick out hawks' eyes, they consider it would be wrong to cause their death. As to the destruction they occasioned, they admitted it, but also observed that they would do as much if they were able. It must not therefore be hoped that fishermen will assist in clearing rivers of these monsters; neither will the native sportsman throw away a single charge of powder and ball on such unremunerative game; which he could not sell and would be unable to eat.

The common crocodile, *Crocodilus palustris* and *C. porosus*, are found in most parts of India and Burma. The reptiles, although often termed man-eaters or snub-nosed crocodiles, assist in depopulating the waters of fish, and it has appeared to me that it is only when they find an insufficiency in the finny supply and carrion that they turn their attention to man and the larger mammals. Every traveler in the East must have seen these logs of wood, as they appear to be, lying for hours at the sides of rivers or on rocks above the surface of the stream, and which sink so noiselessly into the current as almost to make one believe one's eyes had been deceptive, for how could anything so large have so quietly disappeared? In 1868, when at Cuttack, the crocodiles' appetites were not appeased by the fish they obtained, so they commenced consuming human beings, horses, and cows, varying their diet with an occasional sheep or goat. Doubtless, in large rivers, as the Ganges, these reptiles have their redeeming qualities, being the natural scavengers and consumers of carrion. Human beings are now no longer permitted piously to place their dying relatives by the side of the sacred stream, fill their mouths with mud, and leave them to be carried away by the waters or adjacent crocodiles; neither are corpses interred in the current of the holy river. If fish are insufficient, and the crocodiles are not to be destroyed, from whence are these reptiles to obtain their subsistence? The common law of self-preservation will induce them to feed on the cattle of the neighboring country or on such human beings as unwarily approach too near to the waters in which they reside. This is no fancy sketch, but I will adduce merely two instances that came under my notice in 1868. At Cullara exists a hole or pool in the Nuna River to

which these monsters resort during the dry season, and a short time prior to my visit they had succeeded in carrying off five adult human beings; while near the Baropa weir two women and one horse were taken by crocodiles in a single month.

Otters are likewise very destructive, especially in the hilly districts, and when they have exhausted the fish they turn their attention to the frogs. In fact, the large frogs, *Rana tigrina*, are evidently considered great delicacies by these animals, for when kept domesticated they even seem to prefer them to fish. In some rivers, as the Ganges and Indus, the porpoise, *Platanista*, is a great fish consumer.

When mentioning animals which compete with man in destroying fishes, there are some families that must not be omitted, although I propose only casually to allude to them. Birds which eat fish are exceedingly numerous, not only in the true swimming and wading forms, but even the Indian pewit may be observed during the dry months, taking its share of the smaller examples of the finny tribe which are more or less exposed to view in the drying-up pools. Snakes luxuriate in irrigation canals and revel in luxury at the bases of the larger weirs. In that across the Coleroon, when the water was low, I was plainly able to see these reptiles lying in wait for the fishes attempting to ascend. I should suppose I never saw less than twenty any evening I examined this weir on its down-stream race. Tortoises and turtles are fish consumers; while most fishes prey upon their weaker neighbors or their eggs. Near Ganjam, a native official informed me that he had ventured out one night to see how murrul, the walking-fishes, were captured. The fisherman was provided with a long flexible bamboo as a rod, and as a bait used a live frog. Hardly had the frog splashed into the water when a moderate-sized murrul seized and swallowed it. Desirous of observing what would next occur, the fish was left on the hook, as a bait for anything else. Before long a large water-snake was seen swimming towards it, and soon had the fish inclosed in its capacious jaws, and in this fashion all three were pulled together out of the water. Frogs appear to relish fish-eggs, and to be by no means adverse to devouring the fry occasionally.

Legislative protection of fish.—Considerable discussion arose upon this subject in India, some high officials suggesting that a falling-off in the quantity of freshwater fish is no reason for legislative interference, unless it could be demonstrated that a danger of annihilation existed. The viceroy summed up the question in the following suggestive sentences: "Is the present plan of non-interference likely to insure to future generations the fullest possible supply of this food staple? Is it even such as to insure their inheriting a supply equal to that which now exists. The governor-general in council apprehends that both these questions must be answered in the negative, and not only is there no prospect, as matters now stand, or of an increased supply hereafter, but

that, owing to the absence of precautionary measures and reasonable restrictions, the existing supply is diminishing."

Before concluding this portion of my paper, I must refer to an experiment which has been made in India for the purpose of protecting fisheries. If no destructive waste was existing prior to the commencement of protective measures, no augmentation of the fish would have become apparent; if, however, very beneficial results have ensued, there does not appear any reason why such should not be extended elsewhere. In South Canara, Mr. H. S. Thomas observed that it may be doubted whether the poisoning of rivers or the wholesale destruction of fry is most injurious to fisheries; while the effect of prohibiting the finer and closely-woven bamboo cruives has been that the most ignorant, and therefore the most obstinate, opponents have been convinced by the testimony of their own senses, and have exclaimed, to use their own words, "Truly the river is everywhere bubbling with fry;" and, what is still more to the point, their practice has not belied their words, for they have taken to fishing on grounds that were before considered profitless. Two years' discouragement of poisoning, and one year's discouragement of fine cruives, have worked such a change that it has been demonstrated, beyond cavil even of the ignorant and of the most interestedly opposing, that marked advantage can be reaped from the adoption of these two simple measures alone.

What measures have been instituted in order to mitigate the condition of the fisheries I have been unable to ascertain. Sir Richard Temple says, "No result worthy of note." An act (VII of 1875), however, has been passed for Burma, for the protection of the fisheries; while Mr. Buckland, member of the revenue board in Calcutta, remarked (November, 1879) that the following figures show the progress which is being gradually made at Goalunda, at the confluence of the Ganges, and Brahmapootra, where hilsa fish abound: Fish cured 1875, 1,362 maunds; 1876, 4,835; 1877, 10,800; 1878,* 14,000. He concludes that "there is, therefore, some reason to hope that Dr. Day's proposal may bring some good fruit after awhile."

3.—CONSUMERS OF FISH.

Before passing on to the sea-fisheries, I propose considering what proportion of the people of India and Burma use fish as food, or rather can do so without infringing caste prejudices.

In the Panjab, comparatively few of the inhabitants are prohibited by their religion from consuming fish, but there are many Hindus who reject it, as well as the rural population of some districts. But of those residing in towns, and in hilly ranges, it appears that, if the Brahmans are excepted, the consumption of fish is limited only by the

* This shows an increase of 1,043,215 pounds of fish in a year in one locality, where in the first of the four years nearly 112,073 pounds were prepared.

paucity of the supply and the cost of the article. In Sind fish is generally eaten by the population of the province, whether Mussulman or Hindu, except the Brahmans. In the northwest provinces, containing about 28,000,000 of population, out of twenty returns received from native officials seventeen give more than half of the people as not forbidden by religious scruples to eat fish. In Oudh, the majority of the people appear to eat fish, but the supply is unequal to the demand. In the Bombay Presidency, the majority of the inhabitants of the inland districts are consumers of fish when they can procure it. In Haidarabad, Mysore, and Coorg, more than half the population are fish consumers; in South Canara, 89 per cent; in Madras, the majority, the exceptions being Brahmans, goldsmiths, high-caste Sudras, the followers of Siva, Jains, &c. In Orissa, more than half the people; in Bengal proper, from 90 to 95 per cent; in Assam and Chittagong, almost the entire population; and in Burma, in the form of *nga-pee* its use is universal.

As Buddhists, the Burmese profess a religious horror at the taking of the lives of lower animals, but being immoderately fond of fish diet, they console their consciences (while indulging in it) with the idea that the deaths of those animals used by them as food must be laid to the account of the fishermen, and cannot in any way be attributed to the consumer's fault. The walls of their temples have pictures of the terrible tortures the fishermen will have to endure in a future state of existence. In some of these interesting representations are large fires being stirred up by devils, while other evil spirits are dragging more fishermen in nets towards the burning, fiery furnace, helping on some by striking fishspears into them from behind, and hauling them forward by hooks and lines towards the place of punishment.

But, it may be asked, are these ponghees' (priests') practices in accord with their teachings? By no means, as the following example will show. At Yahdown, on the banks of a branch of the Irawadi, a fisherman (Een Theogye) built a *Kyoung*, or monastery, as his great hope was to be termed a *Kyoung taga*, or founder of a monastery, a highly prized title amongst the Burmese. Ponghees came, and ponghees went away, but they did not care to remain and partake for any lengthened period of the hospitalities of their host and disciple. At last one old priest appeared, who seemed to consider the quarters as desirable. To him, in great trepidation, the owner put the following question, "Why, my father, do not the ponghees approve of my monastery, for none but yourself have remained over the going down of two suns?" "Because, my son," replied the holy man, "do you not break the law by depriving fish of life?" "True," he answered, "but were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law, than to feast while breaking it."

With sorrow the disciple took the priest at his word, and for three days refrained from fishing, giving his preceptor merely vegetables for his diet. On the fourth morning, when the same fare appeared, the ponghee observed, "My son, when you fish the river, does your net extend all across, permitting no fish to escape; or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one-third of the way," he answered. "Well then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into the net, the fault is theirs and not yours. Even Guadama blessed the hunter who met him when he was hungry and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring from whence it had been procured.

Supplies to the markets.—Investigating how the local markets were supplied with fish up to 1873, the replies from native officials gave the following results. In the Panjab one in ten markets was sufficiently supplied; in the northwest provinces, one in three; in Oudh, one in four. In Bombay the amount was stated to be insufficient in all, and the same reports came from Haidarabad, Mysore, and Coorg. In Madras, near the sea, the quantity of fish was sufficient, but only in one in ten of the inland markets. In short, merely one-tenth of the bazars were reported as fully supplied with fish; and of this tenth one-fifth obtained them from the sea-coast.

B.—SEA FISHERIES.

Fisheries, to a more or less extent, exist in the Indian Ocean, as well as up the mouths of the larger rivers, in backwaters and estuaries, while parallel to certain places, especially along the coasts of the Madras Presidency, vast mud banks are present in the sea, having such a thin consistency that many kinds of fish are able to obtain abundance of food there, as well as a suitable locality in which to deposit their ova. The most casual observer cannot fail to perceive how numerous are the varieties and vast the number of the finny tribes in the seas of India, but from some cause—whether due to the legislative enactments and local obstructions, or to native apathy and impecuniosity—the harvest has, up to within the last two years, been comparatively untouched; an enormous amount of food still remains uncaptured, while famines are devastating the contiguous shores.

Want of space must be my excuse for not entering upon the various forms of fishes which populate the seas of India, and I pass on to their economic uses, for their well-stocked fisheries should be exceedingly valuable, as affording an inexhaustible supply of animal food, not only

to persons residing in their vicinity, but also inland, should means exist to transport such in either a fresh or salted condition. The extent of the seaboard of India and Burma has been estimated at 4,611 miles; the fisheries are uninfluenced by recurring droughts, and ought to afford an inexhaustible harvest of food along the entire coast of the country.

Irrespective of mere food, maritime fisheries ought to be serviceable directly, as producing isinglass, fish-oils, and manure; or indirectly, as necessitating materials for the building of vessels, the manufacture of nets, hooks, and lines, the carriage of produce, &c. The modes adopted for utilizing fish as food along the sea-coasts of India and Burma may be considered under (1) fresh fish, how far they can be conveyed inland; (2) dried fish and its varieties; (3) cured or salted fish, and how prepared.

Transporting fresh fish inland.—How far can fresh fish be conveyed inland? In examining this question, if the employment of ice or salt is omitted, the distance sea-fish can be carried inland, while fresh, depends upon several circumstances. The season may curtail this, as during the hot months putrefaction commences very rapidly; while some forms, especially the immature, the herring, and the siluroids, decompose more quickly than others; and the same result follows close packing, or want of protection from the full force of the sun's rays. Usually fish are not landed until after sunrise, while those brought on shore of an evening are generally kept where they are until the next morning, coolies being averse to traveling after dark. On the other hand, facilities of carriage may exist, as railways, water communications passing inland, or arrangements made for this purpose. As a general rule, inland places having no special facilities for carriage do not receive uncured sea-fish in a wholesome condition upwards of 10 miles from the beach where they were landed. Should, however, the fish be first opened and cleaned, some salt rubbed in, and care taken in their conveyance (as warding off the sun's rays), they may be safely carried considerably further. But salt being very expensive, it is seldom employed for this purpose, or else a very slight amount is used, and putrefaction has often set in prior to the fish being disposed of for human food.

Varieties of dried fish.—What varieties of dried fish exist in India? Due to reasons which will be given subsequently, it has become the custom along the shores of British India, which are subject to the salt tax to its full extent, simply to dry fish in the sun. This can be done with smaller and thinner forms, as *Ambassis*, *Equula*, the Bombay duck (*Harpodon nehereus*), many of the herring and small varieties of immature forms, but not with the larger fish; however, even from these last, slices may be cut and sun-dried. In some localities small fish are first buried in the sea-sand, in order to obtain a little saline substance, and subsequently sun-dried. In damp weather such articles rapidly decompose, while in the hot months they are attacked by innumerable insects,

Salted fish.—Lastly, how are fish salted? The processes employed are chiefly divisible into the two following: (1) Those cured with monopoly salt, or salt which has paid the Government tax; and (2) those prepared with salt-earth, or spontaneous and untaxed salt. It must be here remarked that I have very little information as to what changes have been effected during the last five years, but I believe a slight (5 or 10 per cent) import duty has been collected on salt fish landed from foreign ports, while the salt-tax in Sind, Bombay, and Madras has been increased to a very considerable extent. I propose first referring to salt and its cost; for wherever the fisherman or fish-curer can obtain this condiment at a cheap rate, there marine fisheries flourish; where it is dear, his occupation is destroyed, except for the purpose of supplying daily wants and a little surplus for salting or sun-drying. This will be most easily explained by referring to the different districts in detail.

Exportation of salted and dried fish.—The amount of salted and dried fish exported by sea from Indian ports was as follows (the value is given in pounds, computing 1 rupee at 2 shillings*):—

Five years ending.	From Sind.	From South Canara.	From Malabar.	From Coromandel coast.
1857-'58	£8,472	No returns.	No returns.	No returns.
1862-'63	13,064	No returns.	£26,272	No returns.
1867-'68	18,725	£6,969	48,207	£1,753
1872-'73	22,944	14,921	90,849	4,513

The duty on salt in Sind was 2s. a maund of 82½ pounds avoirdupois, sometimes less, during the entire period comprised in the above table.

Government tax on salt.—The first great increase in salting fish occurred in 1860-'61, in which year the duty was raised in Bombay from 2s. to 2s. 6d. a maund. The next spurt of this trade, in Sind, was in 1864-'65, when the salt-duty in Bombay was again raised from 2s. 6d. to 3s. a maund. Possibly the importations into that Presidency from Sind would subsequently have been more, but the Government decided, in 1867, to admit all salt fish from foreign ports, where no salt-duty exists, into British India free of duty, to the immense advantage of the Portuguese settlements and the Meckran coast, but completing the ruin of Indo-British fishermen and fish-curers, unless they were advantageously located.

In olden times salt was allowed duty-free in British territory, for salting fish; but this enactment was repealed (year not ascertained) because the excise officers considered that it assisted smuggling.

The following table, being returns from different districts on the west or Malabar coast of Madras, shows the annual sales of Government or

*In the United States the shilling is worth 24.3 cents, and the rupee is worth 43.6 cents.

monopoly salt, along with the value of the salted and dried fish, which were exported by sea:

Year.	South Canara.		Canore.		Tellicheri.		Travancore and Cochin.	
	Fish.	Salt sold.	Fish.	Salt sold.	Fish.	Salt sold.	Fish.	Salt sold.
		<i>Maunds.</i>		<i>Maunds.</i>		<i>Maunds.</i>		<i>Maunds.</i>
1863-1864.....	£1,057	191,002	£96	11,653	£1,459	72,505	£5,416	728,268
1864-1865.....	3,036	168,279	219	7,932	1,504	57,516	6,052	643,597
1865-1866.....	875	184,174	11	9,856	194	62,135	7,061	672,370
1866-1867.....	1,124	151,113	12	9,728	1,825	57,381	7,337	497,988
1867-1868.....	875	174,629	303	8,721	2,011	56,502	7,803	558,766
1868-1869.....	114	176,465	520	9,045	4,319	63,340	7,130	573,639
1869-1870.....	2,053	147,173	4,340	8,807	5,839	72,616	6,096	574,119
1870-1871.....	2,927	136,967	1,470	7,932	5,309	57,624	5,833	593,389
1871-1872.....	2,845	177,482	695	12,008	5,340	88,674	6,987	577,268
1872-1873.....	5,980	135,839	951	6,985	8,429	77,332	.....	.....

The table shows that the amount of annual exports of salt and dried fish in Western India had very little, if any, connection with the quantity of monopoly salt which was disposed of.

Curing fish with salt earth.—In the native state of Cochin, the sale of salt in ten years, ending 1872-'73, owing to augmented duty, was reduced by two-thirds, while it was during this very period that the great increase in the amount of exported salt fish began. In the contiguous British district of Chowghaut, although in the year 1872 £1,067 8s. worth of salt fish were exported, only £46 worth of monopoly salt was disposed of. The cause of this is susceptible of an easy explanation. Owing to some flaw in the land or revenue laws, or else due to an immemorial custom, it was ruled that the people might collect salt earth in order to cure fish for their own consumption; while, there being no law restricting their disposing of any surplus they possessed, a large trade in selling such sprang up. Consequently, fish-curing did not require a large capital to commence with. This induced an increased demand for fish; the fishermen's trade became remunerative, and an immense amount of animal food found its way into the market which would otherwise have been lost. That this is the correct explanation is shown by examining the state of the fisheries on the eastern coast of the Madras Presidency at the same period. There the right to gather salt earth is not recognized, but, observed one official, the practice of salting fish must be increasing, considering that the price of the fish, which formerly cost 2s., has been reduced to 1s. 3d. or 1s. 6d. This reduced value of the fish was doubtless due, not to the increased prosperity of the fishermen, who were evidently in a miserably poor state, but that the absence of salt wherewith to cure fish had diminished the demand for the article, and fishermen had to be content with a lessened price. The Madras revenue board* (May 14, 1873), observed that the fishermen numbered through-

* One of the members of the revenue board at Madras, writing to me on November 8, 1882, observed, "The industry (of salting fish) is really commencing at last; 400 tons more were salted this year than last, and 80 more yards for curing are to be opened in a month or two."

out the Madras Presidency 394,735 persons; that the answers elicited by the questions put by Dr. Day have directed the attention of the board to the subject of the influence of the salt duties on the trade of fish-curing, and they see reason to think that a great practical hardship exists, which they would advocate immediate endeavors to alleviate. A small amount of fish is prepared with monopoly salt in Madras,† especially for local consumption and export to Ceylon; but the amount of this condiment employed by fish-curers cannot be great, as it makes no perceptible figure in the amount of salt disposed of. In Bengal, the excised salt appears never to be employed for fish-curing, and the fisheries are in a neglected state; or, as observed by the collector of Bala-sore, "Fish sold in the markets are so stale that no European would touch them, and most of them are putrid. The people in this district do not salt their fish; they dry them in the sun, and eat them when they are putrid. They like them in this way, and there is no reason why this should be interfered with." Salt was then (1870) subject to a duty of 10s. for 82 pounds weight. Farther to the eastward, in Burma, the salt duty was 1s. for the same quantity, sun-dried fish a rarity, the fisherman's trade flourishing, while salt fish, or crustaceans in the form of *nga-pee*, invariably formed part of every meal among the indigenous population.

Proportion of salt to fish.—It will be necessary to remark upon the amount of salt which must be employed in order to prepare properly a given quantity of fish. In Sind 20 pounds of monopoly salt are added to $82\frac{2}{7}$ pounds of fish; on the western coast of Madras, as Tellicheri, 28 pounds of salt are used to $82\frac{2}{7}$ pounds of small fish, as mackerel, herring, &c. It appears that, for the purposes of the trade, one part of monopoly salt is necessary to about three parts of fish. However, at Gwadur, in Beloochistan, where this condiment is very cheap, a larger proportion of it was used than in either Sind or in India. Fish cured with salt earth, or spontaneous but untaxed salt, require a much larger amount of this antiseptic than they do of monopoly salt, or nearly three (upwards of $2\frac{1}{2}$) parts of salt earth to one part of fish.

Effect of the salt-tax.—The cost of salt, it will be perceived, must have a bearing upon the state of the fisheries; where it is cheapest (other things being equal) the fisherman's trade will be most developed. Along the coasts of Beloochistan, where there was no salt-tax (1873) large communities were supported entirely by fisheries, their captures being cured and exported for the Indian or Chinese markets. The same remark applied to the Portuguese settlements of Goa, Daumaun, and Din, the salt used there costing about 3d. per $82\frac{2}{7}$ pounds weight, whereas in the contiguous British territory it stood at the salt-pans at about 4s. Hence the foreign fishermen were able to use this condiment

†The salt-tax in Madras in 1859 was 2s. per maund, but has since been raised as follows: 1859-'60, 2s. 9d.; 1860-'61, 3s.; 1864-'65, 3s. 4½d.; 1869-'70, 4s.; 1875, 6s.; now 4s.

freely, and the cured articles were preserved in a superior manner, more wholesome to the consumer, and able to be carried farther inland. In short, fisheries thrived along the Beloochistan coast and the Portuguese settlements, due to the excise on salt being not excessive or entirely absent. In the Bombay Presidency the fisherman's market became restricted to the sales for immediate consumption or else for sun-drying, or, as the collector of Tanna observed, "Whether fish is dried as above, in preference to its being salted, is a question I have been unable to ascertain. It is very probable that it has been resorted to in the place of curing by salt consequently on the excise duty levied on salt." Wherever salt earth could be obtained free of duty along the western coast of Madras there the fisheries thrive, the fish-curer requiring a large supply of fish. Along the east coast of Madras the collection of salt earth was more or less prohibited, and the fisherman's trade, except near large towns, is not very flourishing. But in Bengal the fisheries are, or were, worst off, sun-drying being the only curing which fish obtained. Lastly, in Burma, where salt is cheap, the fisheries were thriving. Before concluding this portion of my subject, I would observe that it is not to be supposed that fish cured with salt earth are of the best quality; on the contrary, it imparts a bitter and unpleasant flavor, and is believed to engender disease. But the poor cannot be particular respecting the taste or smell of their food; the cost is the important question. Salt earth costs about $\frac{1}{2}d.$ a basket of 144 pounds weight, depending upon its quality; but, as I have observed, it takes three times the amount that it is necessary to employ if excised salt is used. But $82\frac{2}{7}$ pounds of monopoly salt was taxed $3s. 7\frac{1}{2}d.$ at this time; now $4s.$; whereas 246 pounds of salt earth cost from three-fourths penny to $1d.$, and this is the reason of the latter being preferred by fish-curers for the purpose of preparing fish for the trade; for if monopoly salt at its present rate was used, the article, at least to the general public, would be simply unpurchasable. Fish are plentiful in the sea. The reason why the harvest remains ungathered is not due to the apathy of the fisherman or the unwillingness of the general public to be consumers of fish, but solely a result of the heavy cost of salt, and that a consequence upon the Indian salt-tax.

1.—CONDITION OF FISHERMEN.

Having briefly enumerated the fish which stock the seas of India, and how the fisherman's and fish-curer's occupations are injured by the incidence of a heavy salt-tax, I pass on to the fishermen and their condition, as it was a few years since. Doubtless, should no sufficient market exist for the produce of their industry, some of these people will leave fishing and engage in other pursuits; while those who remain endeavoring to make a livelihood, as did their forefathers, will seek the cheapest way and easiest method by which such may be accomplished. A very little acquaintance with the habits of fish suffices to teach the

fishermen that the smallest kinds are taken with the greatest ease; as preferring the vicinity of the shore, and seeking their food in shallow waters, they are more readily captured in weirs, or with fixed engines and traps, than are the larger, more predaceous, and strictly deep-sea forms. But by disturbing the shore, and destroying or driving away the small fish and crustacea, the food is being diminished which previously decoyed the larger and more predaceous forms in, thus scaring away what would otherwise be the natural supply; and then it is erroneously asserted that the amount of fish has decreased. The fisherman's business is to supply personal requirements and family wants; consequently, if he obtains as much of the funny tribes as he can find a market for or otherwise employ, no injury is inflicted by such a proceeding; because, so long* as salt is not available (owing to its price) for the purpose of curing the surplus which may have been captured, meeting the small local demand for fresh fish is all that is really requisite.

The deep-sea fishermen, or rather those who ply their occupation outside the shallow waters of the littoral zone, as a rule do so by means of nets, or with hooks and lines. Deep-sea netting is not carried on to any great extent, partly because of the insufficiency of a good market to render such remunerative, and likewise owing to the expense which would be necessary in obtaining the requisite nets, and the cost of building seaworthy boats. Fishermen are not to be ranked among the moneyed classes, and so they have to borrow money, at exorbitant rates of interest, wherewith to supply themselves with the requisites for their work. As an instance, in Sind a net suitable for sea-fishing would involve the outlay of £40 or £50 [about \$225], while it does not usually last more than a year. A boat costs about £100 [\$485], and ought to be serviceable for several successive seasons. The money having been borrowed, the fisherman who is the borrower disposes of the whole of his capture at half the market rates to the person who has supplied him with the money. Still this leaves a surplus, due to the existence of a good market for the fish-curer's trade.

Castes among fishermen.—The sea fishermen in most parts of the coasts of India assert that in olden times they were divided into two distinct classes: (1) Those who captured fish in the deep sea, or beyond their own depth; and (2) others who fished from the shore and in the backwaters and creeks. Now, owing to the depressed state of the fishing trade, the deep-sea fishermen (except where salt is cheap or a good market exists) have taken to the less expensive occupation of plying their work inshore. In several parts of India, more especially in the Madras Presidency, they have customs of a patriarchal nature, but which are more strictly observed on the Coromandel than on the western coast. In Sind there are four divisions of the fisherman caste, each being under its own chief, who is hereditary, and his business is to settle caste disputes and other trifling matters, also to conduct the religious ceremonies con-

nected with marriages and deaths. In the Bombay and Madras Presidencies, headmen to the fishing castes likewise exist; in some localities they are hereditary, in others elective; or should there be no headmen, matters are laid before certain wealthy individuals of their own caste, whose decision is final. In places where the fishermen are native Christians, the priest appears to be appealed to in order to settle disputes.

In olden times the fishing castes held a much more important standing than they at present possess. Commanded by their own chiefs, they were ready to engage in military expeditions. The Samorin, in 1513, sent a deputation to Portugal, and his ambassador, who turned Christian, was knighted under the name of "John of the Cross," by John III. On his return to India he was banished from the Samorin's court, as a renegade from the faith of his fathers. In 1532 he joined the fishermen, and appears to have been installed as their chief, as he headed a deputation of eighty-five of them to Cochin, soliciting the assistance of the Portuguese against the Mohammedans. The whole of the embassy are said to have become converts to the truths of Christianity, so a Portuguese fleet was sent to their relief, and 20,000 are reputed to have immediately consented to be baptized. Ten years subsequently, Xavier instituted a church for these people.

It appears probable that the present organization of the fishing classes is the remains of some ancient system, for on no other supposition can the existence of individuals holding an extensive sway be accounted for. The village or patriarchal system of an elective headman to such of his caste as inhabit each street and hamlet, is what is seen elsewhere among laborers; so likewise is the hereditary headman over several villages. But among the fishermen there exist priestly chiefs, two of whom are to be found on the eastern coast, one being at Madras and the other at Cuddalore, the territory of the former stretching up the Coromandel coast, while that of the latter reaches towards Cape Comorin. A third is found in South Canara, where he exercises spiritual control over a large district, and it is by no means improbable that others may exist. These chiefs, whose offices are hereditary, claim and receive fees and fines from those of their caste living within their jurisdiction, and they are the final referees in all cases of caste or family disputes.

The next grade is also hereditary. These mere petty chiefs or headmen hold sway each over only a few villages; their duties are the same, and some of their fees seem to have to be transmitted to their superior. On one of these headmen dying without heirs, a new one is elected by the people of the caste. Lastly, the fishermen have the elective headman, who is chosen by the residents of a single hamlet; his duties are to decide disputes, to be present at marriages and religious ceremonies, often to fix the work, and assist in certain Government duties; his emoluments appear to be very trifling.

Financial methods and poverty of fishermen.—Passing on to the condition of the fishermen (as it was a few years since) in Sind, they have to

pay a tax of 10s. a ton yearly on their fishing-boats, while I have already alluded to the rate at which they borrow money for the purpose of procuring boats and nets. Here these people are well off. At Gujerat, in Bombay, the fishermen are poor, and the precarious living they make often induces them to accept service as sailors, laborers, or anything that insures them a steady competence. Although following out the condition of the fishermen in various districts must have rather a sameness, it will be necessary to do so in order to see clearly whether these people are really in a prosperous or in a poverty-stricken condition; whether, in short, it is the case that they are in the utmost misery, not due to their own laziness, but as a result of British legislation imposing prohibitory duties on salt, which is even now being made heavier and heavier, regardless of the injury to these people, and the enormous loss of food to the inhabitants at large. In the Junjura district the fishermen supply themselves with boats and nets; six or ten club together to obtain a boat and net, dividing the produce; here they have decreased in numbers. At Broach they are also said to have diminished. The same report comes from Kaira. In Rutnagiri the practice of salting fish has decreased during the last fifteen years in consequence of the increase in the price of salt, but the fisherman are said to have increased. If, however, the practice of curing fish has decreased while the number of fishermen has augmented, such must be due to a greater demand for fresh fish, or else the fishermen, from increased numbers, must be worse off than they previously were. However, the official from Canara gave a similar reply. The commissioner observed that at present no larger number of men are engaged on fisheries than are required to provide sufficient for local consumption. The practice of curing fish has largely diminished, owing partly to the falling off in the amount usually captured, and also to the duty on salt in British territory.

In the Madras Presidency, we are informed that, in the Tinneveli collectorate, the fishermen, as a rule, are a very miserable lot of people, and exceedingly poor. The way in which they work is by a system of advances made by traders, a few of whom reside in each fishing village, and supply all the requisites for fishing, as well as the boats, taking one-third of the captures as their share. In the Nellore district, although no one claims exclusive rights to the sea fisheries, the inhabitants of the different villages are exceedingly tenacious in order to prevent fishermen from other localities plying their occupation within what they believe to be their limits. In the South Canara district, where the use of spontaneous salt is, or rather was, not prohibited, the number of sea fishermen is stated to have increased of late years. This augmentation has been computed as high as 15 per cent. The same symptom of prosperity was reported all down the Malabar coast. At Ponani there is an annual increase in the number of fishermen. At Cananore the owners of boats and nets supply them to these people, as well as advance certain sums of money. The money-lenders sell the

captures, half the proceeds going to either party; if, however, the take is insignificant, the boat and net owners surrender their share to the fishermen. A like plan obtains at Tellicheri, where the fishermen have framed rules for their own guidance, one of which is the right of the first discoverer, among a lot fishing together, to a school of fish; he is allowed to capture them without hindrance from the others, even though at the time when the fish were discovered he was not prepared to launch his net. Passing out of the districts where the free collection of salt earth is permitted, another change for the worse in the condition of the fisherman is reported. In Madura it is said that, on the whole, the sea fishermen have increased, but that the aboriginal fishing castes have decreased, owing to emigration or to their becoming sailors. At Ootipadaram the native official estimates the daily earnings at three pence, taking all the year round, and excluding costs, and at Munjery at from three halfpence to nine pence, while at Tenkarei their earnings are computed at from three pence to one shilling a day. In the Tanjore collectorate they are reported to have decreased in some places, but remained stationary in one locality. A little better report comes from Madras, but there the fishermen are also employed as boatmen, which is very profitable, while the vicinity of large stations affords a sale for fresh fish. Without tracing out the condition of these people in each district on the coast, it will be sufficient to say that they are poor and miserable, but not so badly off as in the Bengal maritime districts, where they appear to be quite poverty-struck. Passing on to Burma, with its cheap salt, we find the sea fishermen well off.

If we pass in review the reports from all the sea districts, we find the fishermen well off in Sind, while, unless in the vicinity of large towns, they are miserably off in the Bombay Presidency. Along the western coast of Madras, with its untaxed salt earth, these people prosper; but once round Cape Comorin, where the collection of spontaneous salt becomes a penal offense, they become, as observes the collector of Tinneveli, a very miserable lot of people, and such is the same account all up the Coromandel coast, except where there are large towns. With poverty we find them reported to be decreasing in numbers, due to cholera or other diseases, emigration, or accepting service as lascars in coasting vessels. These are a people who in olden times were among the most prosperous of the inhabitants along the coasts of India; who, when the Portuguese first landed, were able to bring large armies into the field; whose occupation is now thought unworthy of the care of the legislature, except when it seems possible to impose new taxes on their industry, in the shape of an augmented salt-duty—as a European official remarked, that sympathy ought not to be wasted on fishermen, for they are an independent, careless, and drunken set of men. This gentleman, trained up in the latest school of political economy, I believe, merely placed on record what are the feelings of many who are acquainted with the state of this trade, for by careless and independent

he probably meant idle, which idleness is due, first, as I have already explained, to the incidence of the salt-tax; and, secondly, that when salt is unobtainable, did they exert themselves, the market would become overstocked.

Résumé.—Such is a brief outline of the fisheries of India, the part they subserve in providing food for the people, and the hindrances under which they suffer. Excellent and painstaking as are our Indian officials, there are but few among them who have time to interest themselves respecting the complex question of fisheries, while the fishermen are among the most patient of the races of India, and the least likely to bring their grievances to notice. It thus comes to pass that the philanthropist, with mistaken zeal, throws open freshwater fisheries to the people, causing their depletion or almost ruin.

The legislator believes that permitting the fishermen to collect salt earth, or obtain salt duty free, will only be assisting the smuggler, and allows him no exemption. The financier, requiring money, sees in salt-taxes the best means of obtaining it, and forgets, or perhaps never investigates into, how such is detrimental to the health of the inhabitants, and ruinous to the fisheries; while the high official who permits matters to drift as every chance wind blows is merely following, in respect to fisheries, the example given in this country, where they are by turns cared for or disregarded, and every interest save those of the finny tribes has its advocates and upholders of its vested rights.

XIV.—EEL-FISHING WITH SO-CALLED “HOMMOR” (A SPECIES OF FISH-POT) ON THE BALTIC COAST OF SWEDEN AND IN THE SOUND.*

By RUDOLPH LUNDBERG.

The eel is certainly found along the entire coast of Sweden, and everywhere forms an object of fisheries, although their extent, and consequent economical value, vary greatly on different portions of the coast. On our coasts we must distinguish between two kinds of eel-fisheries—those which aim at the eels which are found on our coasts all the year round, and those whose object is the migratory eel, which are only carried on during the latter part of summer and during autumn, with a special apparatus, constructed for catching migratory eels, the so-called “hommor.”†

These last-mentioned fisheries are, beyond a question, the largest and most important, and both for this reason and for the sake of the conclusions relative to the mode of life of the eel, which may be drawn from the data gathered so far, as well as the hints for further investigations which they furnish, I have thought that a brief review of this fishery would be of interest.

Before going any further, I deem it necessary to say a few words with regard to the character of the apparatus in question, or the so-called “hommor,” and the manner of carrying on this fishery.

*“Om ålfisket med s. k. hommor vid svenska Östersjökusten samt Öresund.” Stockholm, 1881. Translated from the Swedish by HERMAN JACOBSON.

†The fishermen make a distinction between the stationary and the migratory eel. Whether these different eels must be considered as separate species or only as various stages of age and sex, is a question which I will not attempt to answer, as I have not had an opportunity to investigate the subject. Krøyer considers the migratory eel as a separate species (*Anguilla migratoria*), and even Nilsson gives it a special name (*Muræna acutirostris*). Ekström, Yarrel, and some of the older zoologists distinguish several species of eels. More recent naturalists, like Siebold, think that there is only one species of the European eel, and even Günther thinks that these differences, principally relating to a difference in the shape of the nose, do not entitle us to assume different species of eels. Günther, however, makes a distinction, based on a difference in the position of the fins, between two European species of eels, viz, the *Anguilla vulgaris* and the *Anguilla latirostris*. The varieties of the eel distinguished by our fishermen are the same as those given in Nilsson's “Fauna”; but the fishermen pay less attention to the shape of the nose than to the color, which with the grass-eel or coast eel is a yellowish green, and with the migratory eel white or whitish gray, and to the size and flavor. The grass-eel is smaller, has softer meat, and is leaner than the migratory eel.

The "homma" must be considered as a large fish-pot, with one or, generally, two arms on the sides, one being considerably shorter than the other. They are always set, beginning at the coast, either one by itself or several in a row, the longer arm of each succeeding "homma" extending alongside or back of the one in front of it.

THE EXTENT OF THE FISHERY.

I now proceed to give an idea of the extent of this fishery. The northernmost point, as far as I know, where eel-fisheries with "hommor" are carried on, is the neighborhood of Grissleham, and the coast south of that place towards Arholma and Tjockö, where this fishery is said to have commenced about the year 1840. We do not meet with any "hommor" eel-fisheries till we reach the southern part of the coast near Stockholm, from Elfsnabben to Landsort. On the coast of Södermanland and the northern part of the coast of Östergötland no "hommor" eel-fisheries are carried on. These fisheries, however, commence again in the southern part of the coast of Östergötland, beginning in the neighborhood of Arkö, and are carried on along the entire coast of the Kalmar district as far south as the city of Kalmar. I am not prepared to say at the present time how far south of Kalmar, towards the boundary of Blekinge, these fisheries extend. On the coast of Blekinge these fisheries are carried on from Christianopel, and farther south towards the districts of Thorhamn and Sturkö. From the latter place they decline, and are only carried on along the outer coast-line as far south as Carlshamn and the inner part of the Hanö Bay, where from time immemorial very considerable eel-fisheries have been carried on, along the coast of the Mjellby district, from Nordersund and Hörvik as far as Pukavik. The migratory eel, however, do not visit the southern part of Listerland, but are found in large numbers on the eastern coast of Scania, from Åhus and Yngsjö, as far as Stenshufvud, where eel-fisheries are carried on along the entire coast, and farther south, past Sandhammaren and as far as Käseberga. Between the last-mentioned place and Abbekås the migratory eel does not come near the coast. Near Abbekås, however, there are considerable "hommor" eel-fisheries, but after that we do not find any till west of Trelleborg, principally in the Kämpinge Bay, and as far as Cape Falsterbo. On the other side of this cape, and towards the sound, no "hommor" eel-fisheries are met with on the Swedish side of the sound until we reach Råå, immediately south of Helsingborg and farther north towards the fishing station of Viken, where these fisheries come to an end. On the Danish side of the sound, however, "hommor" eel-fisheries are found both west of Salholm, on the outer (eastern) side of Amager and farther up the sound near Humlebeck and Helsingör.* On the Danish side these fisheries cease north of Helsingör. Formerly there were eel-fisheries near Aalsgård, im-

* See G. Winther's admirable treatise, "*Bidrag til Kundskab om Fiskeriet ved Torbæk*" in "*Nordisk Tidsskrift for Fiskeri*," vol. i, p. 316.

mediately north of Helsingör, but at the present time they have ceased entirely.* Even in the Great and Little Belts, and along a part of the eastern coast of Jutland, "hommor" eel-fisheries are carried on in several places.† The above indications as to the extent of the "hommor" fisheries also show very distinctly the route followed by the eels in their migrations along the coast. We see therefrom how the eels, after having passed by certain parts of the Swedish coast, such as the coast of Södermanland, &c., finally cross over towards the Danish coast from Falsterbo, and only again make their appearance on the Swedish coast in the narrowest part of the sound, near Helsingborg.‡ The reasons why the migratory eels do not approach every portion of the coast, must probably be found in the varying depth of water near the coast, the different currents, and other circumstances as yet not fully explained. It is also possible that favorable places for these fisheries are found on those parts of the coast which, as I said above, the eels pass by, although no such fisheries have ever been attempted there. Various circumstances, however, speak against such a supposition. It is hardly probable that as easy and remunerative fisheries as the "hommor" eel-fisheries should not have been attempted in these parts of the coast, if there had been any prospect of success; and as far as I could learn from the fishermen, such attempts have been made in several parts of the coast of Scania, where "hommor" fisheries had so far not been carried on, but without success.§ I will not deny, however, that there may be some places where these fisheries have not been carried on, but which may be considered suitable for the purpose.

From olden times it has been known to the fishermen that the eels migrate along the coast, and even scientists like Krøyer, Nilsson, and others have called attention to this fact, but these migrations of the grown eels have, nevertheless, been less noticed by naturalists than they deserve, and the principal question discussed in works on the fauna has been the ascent of the young of the eel from the sea into the rivers. That a migration takes place along the coast is evident from the position in which the apparatus (the "hommor") has to be placed, if any considerable number of eels are to be caught. Along our entire eastern coast the "hommor" are placed so that the eels must enter them from the north, on the south coast of Scania from the east, and up in the Sound from the south. This circumstance can hardly be caused by an accident. On the Danish coasts of the Great and Little Belts, and other coasts,

* See J. Collin, "*Nordisk Tidsskrift for Fiskeri*," vol. i, p. 355.

† See G. Winther, "*Om Fiskeriet i Stone Belt*" (*Nordisk Tidsskrift for Fiskeri*, vol. ii); also, "*Forsøg till oversigt over Fiskeriet: Danmark redrørende ældre og nyere Lovregler*" (*Nordisk Tidsskrift for Fiskeri*, vol. i, p. 240); and also Krøyer, "*Danmarks Fiske*."

‡ Those parts of the coast which are visited by the eels during their migrations are marked on the map which accompanied my treatise in the German language: "*Notizen über die Schwedischen Fischereien I*," published for the Berlin exposition.

§ Experiments will, during the present year, be made on the coast of Södermanland, the results of which will doubtless throw some light on this subject.

it is stated that the eels likewise come from the east and south, and follow a northerly direction into the Kattegat.* The fishermen everywhere declare that it will not do to reverse the position of the "hommor," as the eels invariably follow the route along the coast indicated above.† In the frequent quarrels between the fishermen about trespassing on each other's fishing-grounds, the question is never that a fishery back of another does harm to the one in front, but the very reverse. Everywhere the eels are said to approach the coast from the depths of the sea, where they follow the long arm of the "hommor" and are thus led into them. That this is actually the case appears from the circumstance that fish may be caught in rows of "hommar" placed one behind the other. This movement from the depth of the sea towards the coast does by no means, however, disprove the correctness of the opinion that, on the whole, the eels move along the coast. A circumstance speaking in favor of this opinion, is this as we shall see, that the eel-fisheries commence later in autumn the farther down we go along the coast. The approach of the eels from the depths of the sea towards the coast might easily lead us to think that the alleged migration of the eels along the coast is in reality nothing but a crossing and recrossing between the depths and the coast, but this supposition, which lies very near, is thoroughly disproved by the manner in which the "hommor" have to be placed if any catch is to be looked for. The opinion advanced by Sundevall, that, owing to some peculiarity in its "structure," the eel on our coasts should be obliged in its migrations to constantly turn to the left, seems entirely unreasonable, and that such is not the case appears from the circumstance that on the coast of Östergötland the "hommor" are in various places located on the inner or land side of the islands, and that even in this case the long arm of the apparatus must be placed on the southern side, as the eels come from the north. Since we, therefore, may consider it as certain that a migration of eels really takes place along the coasts of Sweden and Denmark, and out into the Kattegat, the question arises, "Where do these eels come from, and which is the end of their migration?"

There can hardly be any doubt that the migratory eels are, to a very large extent at least, eels which have entered the sea from fresh waters, and also that this migration is, in some way, connected with the process of propagation, and is therefore analogous to the ascent from the sea into the rivers of the salmon and other similar fish. In the foreign literature on the subject to which I have had access, I have in vain searched for information relative to similar migrations of the eels along the coast,

* See "*Nordisk Tidsskrift for Fiskeri*," vols. i and ii.

† According to information furnished by Mr. O. W. Areschoug of Esperöd, proprietor of one of the largest eel-fisheries in Scania, to whom I am indebted for many interesting data regarding these fisheries, such attempts invariably prove failures, although occasionally, when there is a southern current, a few eels may be caught in "hommor" placed with their opening towards the south.

and it therefore seems that in other countries such migrations do not occur. Löberg speaks of a kind of eel-fisheries with a sort of fish-pots on the coast of Norway, and mentions that there, too, the eels go in a southerly direction, but from his remarks it appears that these fisheries are only carried on near the mouths of rivers.* Kröyer supposes that the object of the eel in wandering along the coast is to seek deeper and salter waters, and that those eels which pass the coasts of Denmark are principally fresh-water eels from the rivers Oder, Vistula, and other rivers flowing into the Baltic.† He does not state, however, in how far he considers salt water necessary for the spawning of the eel. If this view of Kröyer, that the eels seek salter waters, is correct—and in itself it seems highly probable to suppose that salt water is of the same importance for the development of the spawn of the eel, as fresh water for the development of the spawn of the salmon and other fish, as otherwise the migration of the eels from the rivers into the sea seems utterly inexplicable—we can easily explain why the migrations of the eels along the coast are noticed particularly on the coasts of the Baltic, and especially in those parts of this sea which have an immediate connection with the salter waters of the Kattegat, but not on the coasts of England, France, or Italy, which countries are surrounded by waters which are a great deal salter than the Baltic. Löberg's statement, referred to above, regarding the migrations of the eels on the coast of Norway, seems to speak against this view, but as the migrations of the eels are, in Norway, confined to the mouths of rivers, this statement does, in my opinion, not disprove the assertion that the saltiness of the water is the cause of the migrations of the eels along the coast.

In his description of the large and well-known Italian eel-fisheries near Comacchio,‡ Jacoby expresses the opinion that the migration of the eels into the sea, or the so-called "calata," is favored by the circumstance that when in summer the water evaporates, the saltiness of the lagoons becomes too great, for which reason the eels eagerly seek the sea-water, which is less salty—an opinion entirely opposed to the one expressed above. The spawning process probably is the principal cause, particularly as the lagoons of Comacchio hardly contain any suitable spawning places for eels. It would, moreover, doubtless be an error to explain the migrations of the eels as exclusively depending on the character of the water, as, like the migrations of other fish, they are also caused by other circumstances, which are not yet fully understood, and which may be comprised under the head of what is called the "migratory instinct." But whatever may be the causes of the migrations of the eel, I think that it is evident from what has been said above regarding the eel-fisheries on the Baltic coast that such migrations take place, and that a more thorough investigation of these fisheries, even

* *Norges Fiskerier*, 1864, pp. 298, 299.

† *Danmarks Fiske*, vol. iii, p. 636.

‡ "*Der Fischfang in der Lagune von Comacchio, &c.*," Berlin 1880, p. 75.

from a purely scientific stand-point, is of very great interest, amongst the rest with regard to the question where and when the spawning of the eel takes place; for this reason I have deemed it proper to call attention to this subject, and shall now continue my review of the eel-fisheries.

THE SEASON WHEN THE EEL-FISHERIES ARE CARRIED ON, AND THE CIRCUMSTANCES WHICH ARE SUPPOSED TO INFLUENCE THE SAME.

The "hommor" eel-fisheries are everywhere confined to the latter part of summer and autumn. Near Grissleham and Landsort they are reported to begin about the 29th July, and last till the beginning of October, when night-frosts set in. On the coast of Östergötland, Kalmar, and Blekinge the fisheries also commence towards the end of July or the beginning of August, and come to a close in October, and sometimes in November. On the coasts of Scania the fisheries never begin until some time in August, and are generally but little productive until September and October. In November they decline, and if any eels are caught in December it is an exception.* In the Sound the eel-fisheries do not commence till September, and most eels are caught during October. Near Humlebeck, on the Danish side of the Sound, about one (Danish) mile southwest of Elsinore (Helsingör), the fisheries commence on the 1st of October, and always close on the 10th of November.† The further up the Sound we go, the later in autumn are the fisheries carried on, which certainly confirms the opinion that the eels wander along the coast in a northerly direction out into the Kattegat. As regards the time when the eel-fisheries are carried on, it should be stated that darkness is the only time when these fisheries can be engaged in, and that their beginning therefore depends on the time when a change of the moon takes place. During dark nights the best hauls are made. During moonlight nights, on the other hand, none or but very few eels are caught, and most fishermen do not set their apparatus in such nights.‡ In the beginning of the fishing season the eel-fisheries are nowhere very productive, but few eels being caught during July. Under ordinary circumstances the best time for eel-fishing is in September, and higher up the sound in October. Later in autumn the fisheries gradually decline, and generally come to a close as soon as snow begins to fall. The eel seems to stir about principally during the night; during daytime hardly any

* In the Great Belt the eel-fisheries with fish-pots do not commence till the end of September or the beginning of October, and the fish-pots are left in the water during two new moons. Near Nyborg attempts were made to continue the fisheries till Christmas, but only *one* eel was caught during December.

† J. Collin, *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 182.

‡ From information furnished by Mr. Areschoug it appears, however, that even during a full moon good hauls can be made, if the water is previously stirred up by a storm, and a light sea-breeze keeps it agitated.

are caught. As with other fish, wind and current are of considerable importance as regards the eel-fisheries. The data we possess in this respect are, however, still too incomplete to draw from them any certain general conclusions.* Near Grissleham southeasterly wind was considered the most favorable, but north, northeasterly, and east wind as unfavorable for the eel-fisheries. Near Landsort, south wind is considered favorable, but north and northwest wind unfavorable. Near Harstena, on the coast of Östergötland, the best eel-fisheries are said to be when the wind is south or east. West wind is not considered unfavorable, but when north wind prevails no eels are caught. On the coast north of Helsingborg south and west wind and rainy weather are considered favorable for the eel-fisheries. Near Kivik, on the eastern coast of Scania, a faint northeasterly or easterly breeze is in some places considered most favorable, whilst in other places the same is thought as regards strong west wind. The best hauls are made with a tolerably strong northerly current.† (Areschoug.) I am strongly inclined to suppose that the different currents and the varying depth of water near the coast play an important part in the migrations of the eels, and are the principal causes why the eels, as has been stated above, in their migrations pass by certain parts of the coast. Thus an old fisherman near Ystad stated that the reason why the eels did not visit that part of the coast in any considerable number must be sought in the depth of water outside that coast, where the eels, instead of going towards the land, turn and go out to sea again. Among other conditions of the weather which are considered to have an influence on the eel-fisheries, cloudy and rainy weather seem, as a general rule, to be considered favorable. Near Kivik great heat during summer, and calm, which favors the so-called "blooming" of the water (the development of a kind of floating algæ), seem to be favorable for the eel-fisheries. The eel is always said to seek a bottom overgrown with grass and algæ, and the fishermen, therefore, like to set the "hommor" on such bottom; but also on stony bottom, as is generally found on our coasts, and on sandy bottom (the coast of Scania) with or without vegetation. If, as is generally the case, in Blekinge and Scania, the "hommor" are set in rows, one back of the other, sometimes to the number of 30, the catch is but rarely distributed evenly among all the "hommor," but more fish are generally caught in those nearer the land than in those on the outside. Near Kivik it has been observed that during west wind the eels come very near to the land, whilst during east wind they go farther out to sea. (Areschoug.)

* Krøyer states that the eels leave the coast during land wind, but approach it again when the wind blows over the land.

† In the Great Belt south wind is in some places, and north wind in others, considered favorable; for both these winds cause a faint current along the coast, and keep the water a little agitated, which causes the eels to halt in their wanderings. G. Winther, *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 251.

FISHING APPARATUS, AND THE MANNER IN WHICH THEY ARE USED.

The so-called "hommor" are, as has already been stated, a kind of fish-pot, varying in size, but always constructed on the same principle. In accordance with different local circumstances and usages, there are, however, some differences in this apparatus, which at first sight cause a casual observer to think that what is really one and the same apparatus, is a variety of different apparatuses. One can principally distinguish two kinds: those which are intended to be placed on stony bottom, and those which are used on even sand or clay bottom. To the first kind belong the apparatus used on the coasts of the districts of Stockholm, Östergötland, and Kalmar, and to the second, those used on the coasts of Blekinge and Scania. The former are generally smaller and narrower. As a good representative type of this apparatus the one used on the coast of the Kalmar district may be taken. It has only one arm, varying in length from 15 to 42 feet, according to the depth of water in which the apparatus is set, starting from the left side of the opening.*

Here begins the so-called "hat," consisting, like a common fish-pot, of a semicircular hoop, from 3 to 4 feet across, and following this, rings, at intervals of 1 foot, gradually decreasing in size, so that those at the farther end measure only 6 to 8 inches in diameter, the whole being covered with netting. At the end of this so-called "hat" (generally 15 to 24 feet long), which like a fish-pot has funnel-shaped entrances, there is fastened the so-called "tub," plaited of thin branches, in which the eels are finally caught. To keep this "tub" steadily in position, it is placed on a frame-work of wood. The apparatus is anchored, and held in position by ropes† to which tolerably heavy stones are fastened. To each stone there is moreover fastened a line with a float, by which the line is hauled in, when the apparatus is to be emptied or taken up. Near Örö (in the district of Kalmar) four similar weights (two on each side) are used for the wide part of the apparatus, a like number to keep the arm in position, and one large stone for the "tub." In stormy weather it becomes necessary to make use of more anchoring to keep the apparatus in position. To prevent the eels from going under the arm, which might be the case, especially when the bottom is very uneven, the lower part of the arm is pressed a little against the net through the meshes, so that its lower part comes to lie close along the bottom.

Near Landsort the so-called "tub" is not used, whilst it is in use in the northern part of the coast of the Stockholm district; as for the rest, the apparatus used north of Kalmar is in its main outlines the same as the one we have described. From those used in the south of

* Right and left counted in the direction of the apparatus, looking forward from the narrow end of the apparatus.

† In the district of Kalmar ropes are used for this purpose, plaited of very thin branches. These ropes are stronger and more durable than one would suppose, and are frequently used as hauling-lines both in the north and south of Sweden.

Sweden it differs by its long shape and its many rings. The apparatus used near Kivik may be considered as the type of those used in Blekinge and on the eastern and southern coasts of Scania. They are often very large; the arms especially are of considerable length (the long arm 60 to 80, and the short arm 20 to 30 feet; height of the arms 6 to 8 feet). The apparatus proper is 16 to 24 feet long, with a main hoop 4 to 5 feet high (not semicircular), and 5 or 6 rings, at intervals of 3 feet, decreasing in diameter towards the back part of the apparatus, but never quite as small as those described above. No special "tub" of wicker-work is used. On the south coast of Scania the apparatus are smaller than those used on the east coast of Sweden, but otherwise of the same general construction. In the Sound smaller apparatus are also used. The front ring or hoop measures about $2\frac{1}{2}$ feet, and the other two 2 to $1\frac{1}{2}$ feet, respectively, in diameter. Here a so-called "tub" of wicker-work is used. The apparatus proper without this "tub" measures about 10 feet in length. The "tub" is made of willow branches, and has the same shape as those described above. In plaiting this wicker-work the longest switches are allowed to protrude and are twisted together, so as to form a sort of handle at the end. This handle serves to fasten the cable by means of which the "tub" is anchored. The anchor is nothing but a number of large stones resting on a cross-shaped wooden foot, from which extend four branches, which surround the stones, and above are joined in a sort of loop. These kinds of anchors are used even for so-called "bottom-nets."

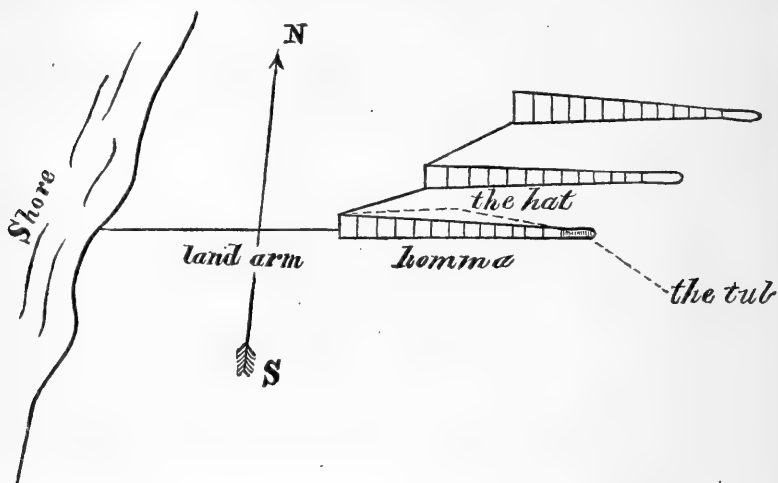
The "hommor"* are here set in a manner differing somewhat from the one generally used, which, however, it would be difficult to understand without a diagram. At the farther end of the apparatus there is fastened a pole, thicker below than at the top, and furnished with a sort of fork, to which are fastened three ropes with anchors, which serve to keep the apparatus in position. These ropes are called after the point of the compass in which the anchor is placed, *e. g.*, the "southeast rope," the "southwest rope," and the "northeast rope;" the "tub" is held in position by a separate anchor, from which, and from the handle mentioned above, a double line extends to the pole, which serves to haul in the apparatus, or to change its position, or to empty the "tub." The "tub" is then loosened from the apparatus proper, emptied, and again fastened to it. In the Sound two arms are also used, a long one (72 to 96 feet long) and a short one (8 feet long). Near Helsingborg no anchors resting on a wooden frame are used, but simply stones tied with ropes.†

Where local circumstances permit, several "hommor" are generally placed in a row, one behind the other, starting from the shore. The more sloping the bottom the larger may be the number of "hommor,"

* These eel "hommor" seem to be the same as the apparatus called in Denmark *Kasteruser*. (*Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 239.)

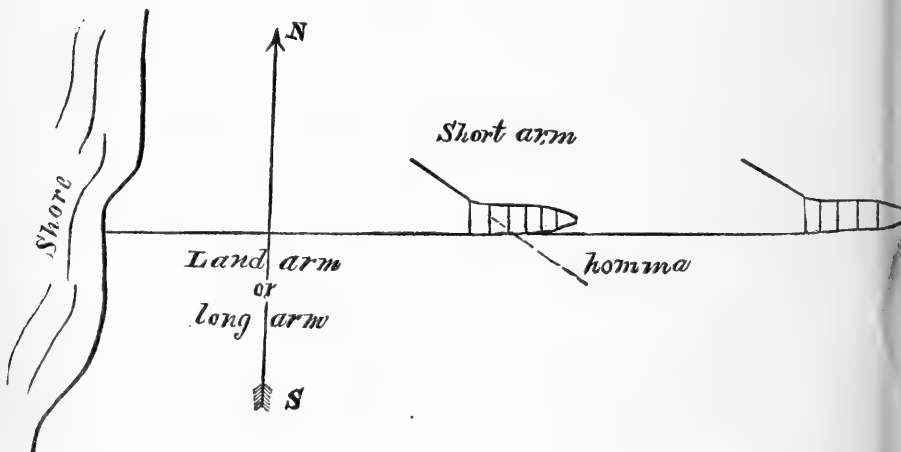
† A full description of the Danish eel-traps has been furnished by J. Collin in *Nordisk Tidsskrift for Fiskeri*, vol. ii, p. 374.

placed one behind the other. Near Grissleham the "hommor" are placed by the side of each other, generally at intervals of 10 and sometimes 5 fathoms. Near Landsort the "hommor" cannot be placed one back of the other, owing to the steep and stony bottom. Near Öro



(Kalmar district) 3, at most 4, "hommor" are placed one behind the other, as shown in the drawing.

In Blekinge and on the east coast of Scania the "hommor" are placed one back of the other in such a manner that each succeeding "hommor's" long arm commences about the middle of the preceding one. (See drawing.) In order, if necessary, to draw on land the entire row of



"hommor" they are united to each other by strong ropes (on certain portions of the east coast of Scania), or (on the south coast of Scania) the lower part of the long arm of the succeeding "hommor" is tied to the lower part of the short arm of the preceding one. According to

Areschoug the places where eel-fisheries are carried on have been called "*drätter*" (from "*draga*"=to draw), whilst near Esperöd, where the "*hommor*" are not bound together, they are called "*sätter*" (from "*sätta*"=to set). In the Sound it is not thought worth while to set "*hommor*" except on grassy bottoms, and the number of "*hommor*" is therefore limited by the extent of these bottoms. Near Råå only 4 "*hommor*" are, for this reason, placed in a row one behind the other, whilst near Helsingborg 16 are set. Each succeeding "*hommor*" is placed right back of the preceding one, so that its long arm reaches up to the "tub" of the preceding one.

The eel "*hommor*" are a large apparatus, and are therefore comparatively expensive. Near Grissleham the price of a "*homma*" is 50 crowns [\$13.40]. Near Örö (in the Kalmar district) the price is 20 crowns [\$5.36], and with the ropes belonging to it 30 crowns [\$7.04]. The large "*hommor*" used on the east coast of Scania and in Blekinge cost 100 crowns [\$26.80] apiece. On the south coast of Scania smaller "*hommor*" are used, which cost 16 crowns [\$4.28] apiece. Near Råå a "*homma*" costs 50 crowns [\$13.40]. If, as is the case in many places, as many as 30 "*hommor*" and more are placed in each row, they represent a very considerable capital.

THE YIELD OF THE EEL-FISHERIES WITH "*HOMMOR*."

It has been impossible so far to obtain full data relative to the yield of the eel-fisheries along the entire stretch of coast where the fisheries are carried on.* But even from the data which we possess it appears that the eel-fisheries with "*hommor*" are of considerable economical value. From the Stockholm district a few statistics are given, which to some extent will show the value of these fisheries. Thus, at Byholma, where 11 fishermen own 50 to 60 "*hommor*," the total average yield per annum was 3,720 pounds of eels. The eels are shipped to Stockholm, and generally are sold at 10 crowns [\$2.68] per "*lispund*" [=18.6 pounds]. The gross income from these fisheries, therefore, amounted to 2,000 crowns [\$536]. On the southern part of the same coast, near Landsort, 1,395 pounds of eels were caught last year, which, at the price of 8 crowns [\$2.14] per "*lispund*," would represent a sum of 600 crowns [\$160.80]. From the statistics given below, taken last year by Mr. V. Wahlberg, regarding the eel-fisheries on the coasts of Östergötland and Kalmar, it appears that the gross receipts from the "*hommor*" eel-fisheries were 17,010 and 27,900 crowns [\$4,558.68 and \$7,477.20], respectively, the price per "*lispund*" being only 6 crowns [\$1.60]. Some years, however, the eels fetch 7 crowns [\$1.87] per "*lispund*," and these prices must be considered as, on the whole, somewhat below the average. From Blekinge we have but few statistics. In 1878 there were in the

* Special statistics of the Scania eel-fisheries have only been furnished for the last two years. Previous fishery statistics did not give separate statistics for each fishery.

district of Kristianopol 185 "hommor," in which there were caught about 18,600 pounds of eels, representing a sum of about 7,000 crowns [\$1,876]. In the districts of Thorshamn and Sturkö, with the islands belonging thereto, the number of "hommor" in 1878 was about 1,000. No data could be obtained as regards the number of eels caught. The number of "hommor" in the western part of this district, from Pukavik as far as Nordersund, is estimated at about 600, and in 1879 about 93,000 pounds of eels were from this district sold to German fish-dealers, which, at a low calculation, would represent the sum of at least 50,000 crowns [\$13,400]. The receipts from the eel-fisheries in the Christianstad district in 1879 were 138,600 crowns [\$37,154.80]. We have, however, no data from some of the fishing stations in this district, and the receipts from these eel-fisheries may, in favorable years, be put down at about 145,000 crowns [\$38,860]. In the Malmö district the eel-fisheries are comparatively insignificant.

As will be seen from the statistics of the last two years, the eel-fisheries vary greatly in different years.

TABLE I.—*Statistics of the eel-fisheries with "hommor" in the districts of Östergötland and Kalmar in 1880, gathered by V. Wahlberg.*

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Östergötland.....	86	312	7,731	\$4,557 68
Kalmar.....	240	1,144	86,490	7,477 20
Total.....	326	1,456	139,221	12,034 88

TABLE II.—*Statistics of the eel-fisheries with "hommor" on the coast of Scania during the years 1879 and 1880.*

1879.

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Christianstad.....	297	4,438	372,539	\$37,152 57
Malmö.....	139	1,662	30,894	3,379 48
Total.....	436	6,100	403,433	40,532 05

1880.

Districts.	Number of fishermen.	Number of "hommor."	Number of pounds of eels caught.	Gross receipts.
Christianstad.....	356	4,689	162,973	\$15,934 24
Malmö.....	237	2,022	41,050	4,010 35
Total.....	593	6,711	204,023	19,934 59

During the year 1879 the eel-fisheries were unusually productive, whilst in 1880, when stormy weather greatly interfered with them, they were in most places even below the average. Mr. Areschoug, of Esperöd, has kindly furnished the accompanying (see plate) interesting graphic

representation, showing the variations of the Esperöd eel-fisheries during the period 1815-1879, from which it appears, amongst the rest, that the year 1879 was the most favorable year during the entire period. Mr. Areschoug justly thinks that, as the fisheries in the other parts of the east coast of Scania are very much like the Esperöd fisheries, said table will give a tolerably correct idea of the variations of the eel-fisheries during that period on the entire coast. It will hardly be necessary to state that data as to wind and current, during this long period, would be exceedingly valuable.* Although the eel-fisheries are generally continued for a period of three months, the richest hauls are generally made during a much shorter period, when the great mass of eels passes the coast, before and after which the yield is generally much smaller. The same is also the case as regards the salmon-fisheries in the rivers. As an illustration, we will state the following relative to the Esperöd fisheries in 1878, kindly communicated by Mr. Areschoug: "Up to September 24th but few eels were caught (18 to 36 pounds a day in each row of 'hommor'), the prevailing wind being west wind. On that day it commenced to blow from the NNE., but not enough to prevent the apparatus from remaining in position. This wind continued for several days, the current being northerly. The wind afterwards changed to SE. and S., but, as a general rule, the wind was more or less north till October 12th, when a gale commenced to blow from the east, which continued till October 25th, cast the apparatus ashore, and put an end to the fisheries. The fisheries of that year actually lasted from September 24th till October 12th, during which period 20 to 70 "lispund" [372 to 1,302 pounds] a day were caught in each row, the yield, therefore, being somewhat above the average. This, however, was an exceptional case." This communication is of special interest as showing the influence of wind and current on the eel-fisheries.

EXTENT OF THE DIFFERENT CATCHES, PRICES PAID FOR EELS, PREPARING EELS, AND PRINCIPAL MARKET FOR EELS.

As the greatest catches in one day in one and the same row of apparatus, Areschoug mentions 90 to 110 "lispund" [1,674 to 2,046 pounds]. At the present time catches of 50 to 60 "lispund" [930 to 1,116 pounds] a day are very rare. It is not stated how many "hommor" were used. Near Öro (Kalmar district) 40 to 60 eels per "homma" is considered a good catch. Catches of 100 to 220 eels per "homma" are regarded as exceptional. The eels, especially in the north, fetch a very good price, and in this respect rival the salmon. The greater portion of the eels are sold, fresh, to fish-dealers.

From the neighborhood of Grissleham the eels are sent to Stockholm, in long, narrow boxes, made of four boards, and resembling a wooden

* It has been resolved that from the present year daily observations of wind and weather, as well as the temperature of the water, shall be taken by the superintendents of the different eel-fisheries.

sewer-pipe. These boxes are taken in tow by lumber ships, sailing to the capital. The price obtained was generally \$2.68 per 18 pounds. At Landsort about one-third of the catch is consumed at home, and two-thirds sent to Södertelje or Stockholm. On the coast of Östergötland and North Kalmar the eels are generally bought by fish-dealers from Norrköping or Stockholm, who visit the principal fishing stations, such as Harstena, and gather the fish in their sailing vessels. In Blekinge and Eastern Scania the greater portion of the eels has, for some years, been sold to German fish-dealers, who keep fishing-smacks on this coast during the entire period of the eel-fisheries. From time to time steamers come from Germany, gather the eels from the fishing-smacks, and take them to Stettin, whence they are sent to Berlin. According to a contract with the Hörvik fishermen, which I had the opportunity to see, the German dealers last year agreed to pay per 19½ pounds [21 Swedish "skålpund"] 8 crowns [\$2.14] in September and October, and 7½ crowns [\$2.01] in August. At Råå the eels vary in price according to their size. Of good eels 20 or 21 should generally go to 1 "lispund" [18.6 pounds], and are sold for 8 crowns [\$2.14], whilst smaller eels are sold for 5 crowns [\$1.34] per "lispund" [18.6 pounds]. Here, as in general along the entire south coast of Scania, the eels are sold in the country to farmers and dealers. It is only since last year that German dealers have visited the Kalmar district, where they had one fishing-smack. There is, therefore, no lack of remunerative and convenient markets, at least as far as the great eel-fisheries are concerned. The great portion of the eels caught on the coasts of Blekinge and Scania are, at the present time, sold fresh, and only small quantities are salted, either for domestic consumption or by salters. On the Kalmar coast a considerable number of eels are salted, and principally sold at the Norrköping autumn fair. The eels are laid in salt brine alive, are then put in kegs and salted once for all (that is, are not taken out again). Near Örö, on the coast of Misterhult, the price of salt eel was about 9 crowns [\$2.41] per "lispund" [18.6 pounds]. Twenty-two "skålpund" of fresh eels are generally calculated to make 15 "skålpund" of salt eel. [The skålpund = $\frac{1}{14}$ of a pound. This shrinkage is about one-third.]

OWNERSHIP OF THE EEL-FISHERIES; THE EEL-FISHERIES IN OLDEN TIMES.

The eel-fisheries with "hommor" are, as appears from the above, exclusively coast fisheries, which in most places are carried on within certain well-defined limits, called in Swedish eel "*drätter*" or "*sätter*" (corresponding to the Danish "*aalestader*" or "*aalegaard*" (eel towns or eel farms). They are frequently known by special names, "*kyledrätten*," "*kungsören*," &c., and their boundaries are well defined till within a few yards from the shore. These eel-fishing places are in Scania and Blekinge considered taxable property. A great portion of the eel-fisheries on the east coast of Scania seem originally to have

belonged to the state, and have since been sold to private individuals. As regards many of them we find it stated that they were bought by the proprietors of Torup in 1697; but as late as 1850, 92 eel-fisheries in the district of Kristianstad are mentioned as belonging to the state, which, however, by royal decree of March 22, 1850, were either sold, or, under the name of "fish revenues," leased to different parties. The same was the case on the coast of Blekinge. In the district of Malmö the state seems to have owned but few eel-fisheries, which shows that the fisheries in that district were not very important (only two fisheries are mentioned to which the fishery regulations of 1850 applied). As far as I could ascertain there were no state or taxed eel-fisheries on the remaining portions of our Baltic coasts. In Nilsson's "Fauna" it is stated that taxed eel-fisheries are found on the coast as far north as Hernösand, but this statement is probably based on a mistake, and refers to the taxed eel-fisheries farther inland. All the taxed eel-fisheries are treated as property, for which a certain tax is paid. According to the old Danish law, the so-called "*forstranden*" (coast front), and therefore the right to fish in its waters, belonged to the King, who gave it to his subjects, either free or for the payment of a certain rent. It appears from old documents that the nobility enjoyed special privileges to have free fishing and eel farms on portions of the coast belonging to them—privileges which were not enjoyed by any and every owner of property along the coast. This exclusive right of the noble owners of eel farms to carry on these fisheries in the sea was by the law of Christian V extended to all owners of such fisheries. As most of the eel-fishing grounds were probably taken up before these provinces (Scania and Blekinge) were ceded to Sweden, no new eel-fisheries have sprung up besides those which had been carried on from time immemorial. In certain portions of the west coast of Scania, *e. g.* near Råå, the eel-fisheries have been free. There is only one place where eels are caught which belongs to farmers, the rest of the fishing places being determined by the fishermen by mutual agreement. The one who first marks the place by anchoring the pole described above is considered to have the right to fish in that place during the year. Near Grisslehamn the fishing water is divided among the shareholders in certain parts, which are worked in turn and are changed every eighth day. If, for example, a shareholder has part *a*, he changes to *b* after eight days,

$$[a | b | c | d | e | f | g | h | i |]$$

and so on; and if he closes the year's fisheries with part *c*, he commences at *f* in the following year. Every part is intended for four "hommor," but the owner has the right, if he desires, to set more. Quarrels arise very frequently among the owners of eel-fisheries, caused by trespassing on each other's fishing grounds, by one of the owners of a preceding part setting too many "hommor," and thus diminishing the number of eels going into the succeeding "hommor," &c. As it some-

times happens that one and the same row of "hommor" has several owners, the outer ones belonging to one and the inner ones to another, there is frequent occasion for quarrels and lawsuits. As was stated above, the distances between the different eel-fisheries are generally carefully defined, as well as the number of "hommor," but there are no rules as to how far from the coast the right of fishing shall extend. As the price of eels has risen the fisheries have sometimes been extended as far as local circumstances would permit. At the present time the "hommor" are set out much farther and in greater number than was the case formerly. Thus, near Kivik, "hommor" are now set at a depth of 9 or 10 fathoms. The fishing population proper, however, is excluded from these easy and profitable fisheries, and, displeased with this, they have during the last few years, in several places, attempted to set "hommor" beyond the boundary lines of the old fishing grounds, claiming that these could not extend farther than the so-called land ground (*land-grund*) extends according to the fishery law of 1852. This has given rise to quarrels and lawsuits between the fishermen and the owners of the taxed fisheries. The same has taken place in Denmark, where circumstances are very similar. It is certainly not to be wondered at that the fishermen feel hurt at seeing themselves exclusively confined to the difficult and, comparatively speaking, less remunerative sea fisheries; but, on the other hand, it cannot be denied that an equitable arrangement of the mutual rights would in this case be connected with great difficulties. It is, at all events, desirable that there should be some distinct legislation on this point. As for the rest, there does not seem to be any necessity for other administrative measures relative to these eel-fisheries.

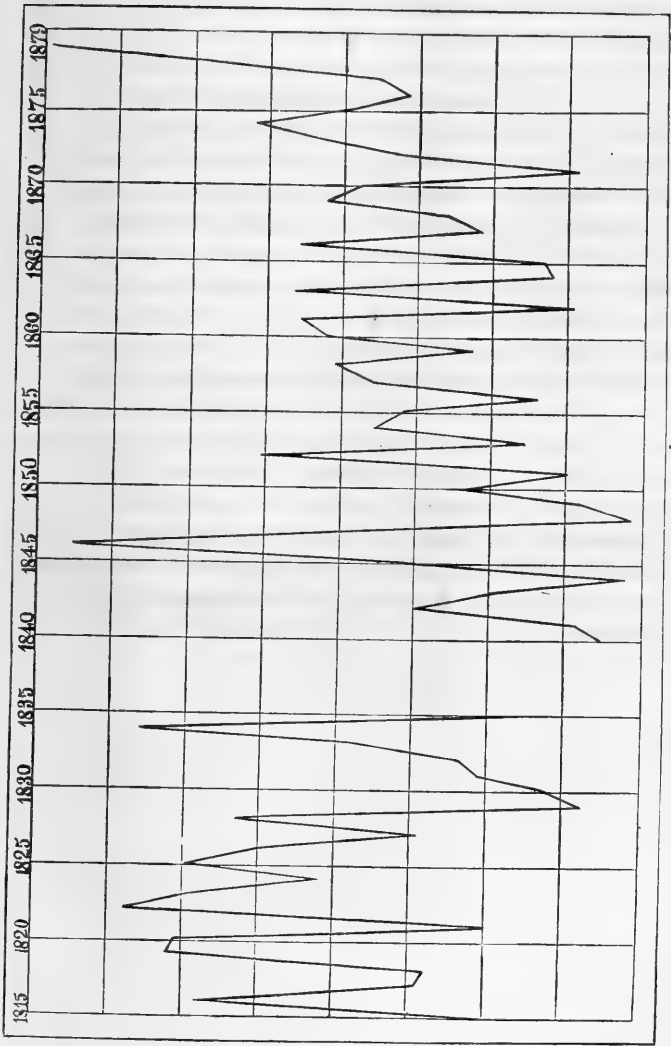


Table showing the variations in the Eel-fisheries near Esperöd and Kivik, in Scania, from 1815 to 1880,
by O. W. Areschoug.

THE HISTORY OF THE

THE HISTORY OF THE	
1	2
3	4
5	6
7	8
9	10
11	12
13	14
15	16
17	18
19	20
21	22
23	24
25	26
27	28
29	30
31	32
33	34
35	36
37	38
39	40
41	42
43	44
45	46
47	48
49	50
51	52
53	54
55	56
57	58
59	60
61	62
63	64
65	66
67	68
69	70
71	72
73	74
75	76
77	78
79	80
81	82
83	84
85	86
87	88
89	90
91	92
93	94
95	96
97	98
99	100



MBL/WHOI LIBRARY



WH 1AHQ H

